Colorado Broadband Mapping Project

FINAL REPORT

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EXECUTIVE SUMMARY

Broadband has become a vital infrastructure in our 21st century society and economy. The availability of broadband internet access is critical to economic development, provides widespread access to essential services (like health care and education), facilitates the delivery of government services, and promotes civic engagement. Consequently, it is important that all parts of the state enjoy access to broadband and that citizens are making the best use of this technology.

In 2008 the Colorado General Assembly passed and Governor Bill Ritter signed into law Senate Bill 215 calling for the creation of a geographic inventory of broadband availability in Colorado to help broadband providers and policymakers better understand the current availability of broadband service throughout the state and to serve as a starting point for developing broadband deployment and adoption strategies. The Governor's Office of Information Technology (OIT) partnered with Connect Colorado to identify areas served and not served by providers of broadband and to develop Geographic Information System (GIS) data and GIS-based maps of these areas. The resulting map products, as well as an examination of the unserved population, preliminary data validation results, and an analysis of broadband deployment and adoption barriers, are included in this report.

Connect Colorado found that 97.53 percent of Colorado households have broadband service available of at least 768 kbps downstream and at least 200 kbps upstream to the end user at the address available. This figure represents 1,617,322 Colorado households with broadband service availability. However, the coverage statistic only reveals a portion of the larger broadband landscape. Broadband capacity/speeds, broadband adoption, rural disparities in broadband deployment, and age of census data should all be considered before broader conclusions are reached.

The primary goal of the project was to gather broadband data and provide visual depictions of service availability to:

- Begin the development of effective policy strategies;
- Direct future initiatives, research, and exploration based on preliminary findings; and
- Ultimately spur broadband deployment and adoption activities.

The report details the broadband data collection process and methodology for processing broadband provider data, explaining the format in which the final data set was delivered and how the data was converted into maps from the GIS data. Further, it includes a demographic analysis of served and unserved populations of the state. The results show a significant variance in broadband availability between urban and rural areas. There are 15 counties with broadband availability of less than 80 percent.

Preliminary validation efforts were conducted to determine if the data gathered from broadband providers was accurate. This included the evaluation of web-based speed tests,

citizen broadband inquiries, and a three-county pilot study. The pilot study conducted in Weld, Garfield, and Las Animas Counties included a survey intended to evaluate broadband adoption barriers and the overall perception of broadband. Broadband pricing, awareness, and speed were a few of the issues identified in the study.

Further, a statewide web-based survey revealed that the internet is being utilized for a myriad of purposes, including obtaining public-sector services. Future broadband-related efforts will need to tackle the important issues of whether capacity is sufficient to run desired applications and whether service is affordable enough to enable citizens to engage in order to effectively develop and implement state policies.

The report also includes a market analysis to reveal information about the current market condition of the state and what may be inhibiting broadband deployment and adoption. It looks at the potential for developing Enterprise Zone-wide broadband deployments and potential infrastructure that could be used to provide services to unserved areas. Finally, the technological, financial, adoption, and topographical hurdles to increased access and usage are examined.

Understanding the current broadband footprint is critically important; however, capacity, adoption, and rural inequity issues deserve equal attention. Basic broadband speeds will allow certain applications to be utilized, but enhancing current infrastructure deployment in many communities will certainly be necessary for residents to take advantage of important online services. Further, outreach and education campaigns are necessary to demonstrate to citizens the importance of broadband to their everyday lives. Finally, policymakers will need to focus deployment efforts on those communities that lack even basic broadband coverage.

This project is only a starting point to help direct and target future broadband-related efforts, and OIT has been awarded approximately $2.1 million in American Recovery and Reinvestment Act grant funds to continue its broadband data collection and mapping activities and to help identify priority areas for activities to promote the deployment and use of broadband service.

INTRODUCTION

Broadband or high speed internet service has become increasingly critical in our 21st century society and economy. Access to broadband provides communities with important tools to enhance their sustainable growth, support innovation and economic prosperity, and improve quality of life and social development. Broadband provides an infrastructure for delivering a host of innovative applications and electronic services in the areas of health, education, government services, and business. Assuring that broadband is available to all citizens in all locations (not only to those in densely populated areas) is necessary to preserve the foundation on which Colorado and the nation have achieved success.

A myriad of opportunities exist and are created when broadband is available and adopted in both urban centers and sparsely-populated communities. The technology allows for greater student career exploration and personal growth by bringing highly qualified teachers and online advanced, foreign language, and elective courses to rural areas that otherwise would not have had these opportunities. Further, it enables patients in remote parts of the state to receive specialized and home health care despite the lack of specialists and home health providers in their communities.

In the area of economic development, broadband service supports the ability for farmers to use GPS technology and computers to improve the efficiency of their planting operations. In another notable example, broadband connections have dramatically improved the marketing and sale of cattle, enabling online auctions that have provided ranchers with access to new markets. Further, broadband provides a sustainable infrastructure that supports on-going economic development and affords people of all ages the opportunity to start businesses that can flourish online and to use online technologies to operate more effectively.

In 2008 the Colorado General Assembly passed and Governor Bill Ritter signed into law Senate Bill 215 calling for the development of a geographic inventory of broadband availability in Colorado to help broadband providers and policymakers better understand the current availability of broadband service throughout the state. The resulting information is intended to provide the starting point for developing a strategy for broadband service deployment to the state's unserved areas and to begin the discussion of how to increase broadband adoption and usage in those areas that are currently served. Broadband mapping is widely viewed as the critical first step to greater broadband deployment and adoption, and the legislation laid the foundation for the development of this important baseline data. SB08-215 did not prescribe how broadband should be deployed; rather, it sought an illustrative way to help broadband providers and policymakers more clearly comprehend the availability of broadband service throughout the state.

The Governor's Office of Information Technology (OIT) contracted with Connect Colorado, LLC, a wholly-owned subsidiary of Connected Nation (CN), for purposes of identifying the areas served by providers of broadband internet and unserved areas within

Colorado and to develop Geographic Information System (GIS) data and maps of such areas.

Basic broadband for purposes of this report is defined as service of at least 768 kilobits per second (kbps) downstream and at least 200 kbps upstream to the end user at the address available. This definition has been adopted by the Federal Communications Commission (FCC) and the National Telecommunications and Information Administration (NTIA) as the minimum speed necessary for a service to be considered broadband. Further, broadband can be delivered over a variety of platforms, including:

- Cable Modem
- Digital Subscriber Line (DSL)
- Fiber-Optic Cable (Fiber)
- Fixed Wireless
- Mobile Wireless
- Satellite

The Connect Colorado contract included the following deliverables:

1. Geographic data set in vector format of broadband coverage in the state aligned with US Census block boundaries and containing information on speed tiers and broadband service technology platforms, including wireless and wireline, for each census block.

2. Analysis of the population not currently served by broadband.

3. Set of maps depicting broadband service areas and population density in areas not currently served by broadband. These maps can be found within this report and electronically at www.colorado.gov/oit. It should be noted that OIT and CN mutually agreed to exclude satellite-provided broadband from the statewide and regional broadband maps. Satellite companies are capable of providing near ubiquitous coverage in Colorado, with only line of sight issues precluding the use of these services. For this reason, it was determined that visually depicting this particular platform was unnecessary.

4. Preliminary validation and verification of broadband data through a variety of mechanisms including: interactive speed test web sites, investigation of available data on provider services, and detailed field verification and resident interviews in three pilot areas in the state.

5. Market analysis and report describing barriers to deployment and adoption of broadband technologies based on data gathered in the project.

6. Interactive web map depicting broadband coverage that allows Colorado residents to enter their address and determine the providers at their address. The tool is located at www.connectcolorado.org.

The ultimate findings and associated mapping artifacts provided to the State of Colorado at the conclusion of the project depict a supply side scenario that is cause for cautious optimism amongst policymakers and citizens of the state. As measured by fifty-six (56) of eighty-two (82) likely Colorado broadband providers (67.5 percent) who participated voluntarily in the Connect Colorado broadband mapping project, the Colorado broadband inventory maps demonstrate that 97.53 percent of Colorado households have broadband service available of at least 768 kbps downstream and at least 200 kbps upstream to the end user at the address available. This figure represents 1,617,322 Colorado households with broadband service availability. This measure of households is based on household counts from the 2000 census.

Broadband service is considered "available" to an end user at an address if a broadband service provider does, or could, within a typical service interval (7 to 10 business days) without an extraordinary commitment of resources, provision two-way data transmission to and from the internet with speeds of at least 768 kbps downstream and at least 200 kbps upstream. This definition provides important context for the figures stated above. While these preliminary results are positive for the State of Colorado, they only reveal a segment of the larger broadband landscape. There are additional aspects of broadband deployment that need to be considered before broader conclusions can be reached. Specifically:

- **Broadband Capacity:** Basic broadband speeds of 768 kbps may not be sufficient for some "covered" households to utilize internet applications and services which are meaningful to them. While some applications run adequately on lower speeds, others like those that enable distance learning and telemedicine are increasingly requiring more and more bandwidth.

- **Demand Side Analysis:** Adoption and usage of broadband is a significant part of the equation. While this project primarily focused on the "supply side" of broadband, broadband awareness and adoption is addressed to some extent later in the report.

- **Urban vs. Rural:** The statewide coverage figure can be misleading when it comes to the rural areas of the state, where access to broadband is significantly lower than in urban areas. As demonstrated in the first table of Appendix A, only 0.04 percent of Denver County households are unserved, which is not surprising given the population density of this urban community. However, more rural counties such as Crowley, Custer, Dolores, Elbert, Hinsdale, Huerfano, Jackson, Las Animas, Lincoln, Mineral, Park, Rio Blanco, Saguache, San Juan and San Miguel all have unserved household percentages greater than twenty. This data suggests the need for a more granular, county-centric approach to identifying broadband deployment solutions.

- **Census Data:** This project appropriately used the 2000 US Census[1] to derive household data in order to accurately align with the geographic data; however, it should be noted that based on 2008 population estimates the current household count is higher now than in 2000. The Colorado State Demography Office estimates

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[1] The US Census is conducted every ten years. The next one is scheduled for 2010.

that Colorado's population changed from 4,301,261 in 2000 to 5,011,390 in 2008, an increase of 16.5 percent. This population increase could impact the overall broadband availability findings.

This broadband mapping project was intended to produce baseline data of broadband availability across the State of Colorado in order to begin the important dialogue of how to expand broadband to unserved areas and increase adoption in those areas that have coverage. While some preliminary market research and analysis of barriers to adoption was included in the efforts of Connect Colorado, the primary goal of the project was to gather broadband data and provide visual depictions of service availability to:

- Begin the development of effective policy strategies;
- Direct future initiatives, research, and exploration based on preliminary findings, such as the reported need for greater backhaul[2] capacity and availability; and
- Ultimately spur broadband deployment and adoption activities.

This report describes the deliverables and the results of analyses performed by Connect Colorado to realize the goals laid out in SB08-215. It begins with a discussion of the development of the data representing broadband availability and continues with a consideration of the analysis of the data through a variety of means and then a more detailed investigation of broadband delivery and use in three pilot areas of the state. It concludes with a discussion of obstacles to broadband deployment and adoption uncovered during this project.

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[2] The backhaul portion of the network comprises the intermediate links between the core, or backbone, of the network and the small sub-networks at the "edge" of the entire hierarchical network. Visualizing the entire hierarchical network as a human skeleton, the core network would be the spine, the backhaul links would be the limbs, the edge networks would be the hands and feet, and the individual links within those edge networks would be the fingers and toes. (Source: www.wikipedia.org)

# BROADBAND DATA COLLECTION, MAPPING, AND ANALYSIS

Broadband Data Collection Process

Connect Colorado's broadband mapping process collected data directly from broadband providers in the state and converted this data to the format required by OIT. Part of this process was the protection of confidential information in a setting of voluntary provider participation. SB08-215 required that OIT hire a contractor to collect and keep confidential the inventory data, thereby protecting the proprietary information and ensuring the participation of broadband service providers. Therefore, Connect Colorado executed non-disclosure agreements (NDAs) with each participating provider, establishing a legal and technical program that ensures full protection of broadband service providers' confidential and proprietary data necessary to complete the maps. To that end, Connect Colorado incorporated the following process in the state's mapping project:

- Full public disclosure from the outset to state officials (program sponsors), providers, and the general public of the type and form of data that Connect Colorado would be releasing publicly and to any government authorities.

- Execution of NDAs with broadband providers. These agreements clearly define how each provider's confidential information would be used and protected. The data that is protected via NDAs is limited to highly sensitive network infrastructure information, which is processed by Connect Colorado to determine the broadband availability footprint and GIS maps. In particular, the specifications of the network infrastructure and equipment, such as the frequencies and beamwidth of wireless signals, latitude/longitude coordinates of digital subscriber line access multiplexers (DSLAMs), and the specifications of fiber routes, remain confidential. The NDAs also protect the confidentiality of provider specific data.

- Established a protocol for data transfer and processing that ensures maximum protection of the confidential data held by Connect Colorado.

- Established an IT-based secure system for data storage and hosting.

Connect Colorado was required to deliver data based on US Census blocks, which is the finest unit of geography used by the US Census Bureau for its population counts. The US Census Bureau uses a hierarchy of geographic units for enumerating and tabulating population and other demographic information. The units in this geographic scheme, in order of relative size from smallest to largest, are blocks, block groups, tracts, and then counties. This scheme is a fully nested hierarchy. In other words, a census block falls within one and only one block group, and block groups contain aggregations of census blocks in

their entirety. Similarly, a block group falls within exactly one tract, and tracts consist of aggregations of whole block groups. The graphic below illustrates the relationship between these geographic units.
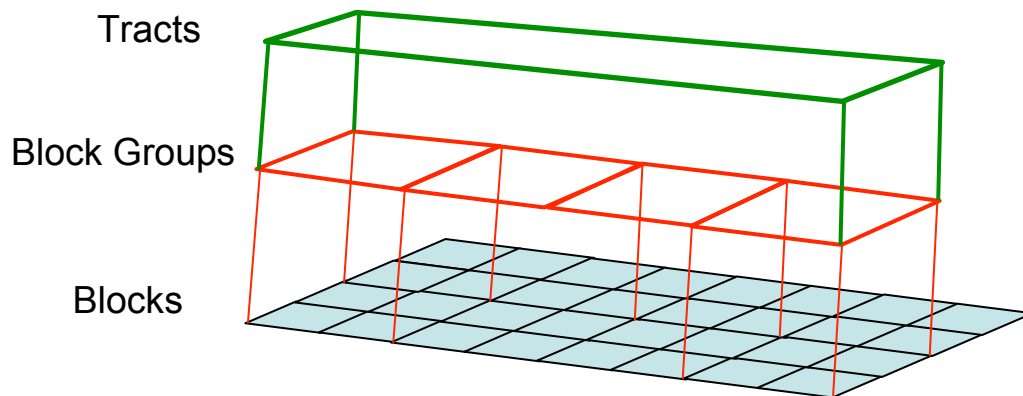
These units can vary significantly in size. In Colorado, census blocks can follow city blocks in urban areas, or they can be much larger in rural areas. They range in size from less than 0.01 square miles to approximately 429 square miles, although the average size is 0.74 square miles. The process for delineating census blocks does not follow concrete rules. Rather it is more of a heuristic process relying on input from local governments. The Census Bureau tries to follow defined features (e.g., roads, streams, etc.) when delineating blocks, but this may not always be appropriate. In rural areas, morphological features (e.g., ridge lines) may be used at times.

The structure of the data set is outlined in Appendix B at the end of the report. For each block, Connect Colorado identified the following information:

- Estimated number of household with broadband availability
- Estimated number of households without any broadband availability
- Highest broadband speed available based on FCC speed tiers
- Availability of cable broadband
- Availability of DSL broadband
- Availability of fixed wireless broadband
- Availability of mobile wireless broadband
- Availability of other broadband
- Population of the block
- Estimated current population of the block

Connect Colorado worked with and received data from 56 providers or nearly 70 percent of all likely broadband providers across the State of Colorado in developing the Connect Colorado broadband map in less than four months.

Broadband Data Processing Methodology

To create the aggregated broadband service inventory for the State of Colorado, Connect Colorado began with processing data from individual providers. Data was received in several different formats including ESRI shape files, CAD data, and spreadsheets. The data primarily included information on service areas, but in some cases it contained infrastructure information from which service areas were inferred based on a coverage distance from the equipment suggested by the broadband providers. In the case of wireless providers, the equipment information was used in signal propagation models to determine service areas. After each provider's broadband service areas were processed, a map of the provider's coverage was sent back to the provider for review and approval. If edits or other corrections were required to ensure more accurate coverage representations, revisions were made to the GIS formatted data and revised maps of coverage were sent to the provider until approved, at which point the data was ready to be included in the statewide data inventory.

After obtaining or determining service areas for individual providers, Connect Colorado merged the individual areas into statewide coverages of broadband service. These were then overlaid with census block data to identify the census blocks that received each type of service. If a census block touched or intersected an area corresponding to a service type, it was identified as having received that type of broadband service. The census blocks were then assigned the appropriate speed tier.

A full data set of census blocks was delivered to OIT in a format compatible with OIT's GIS software allowing OIT to perform further analyses or mapping if desired.

Broadband Coverage Maps

In addition to the digital data, Connect Colorado produced several maps depicting broadband availability, population density, and household density of areas not served by broadband based on the collected and processed data. Statewide maps of broadband availability and population density, as well as maps depicting provider-reported maximum download speeds by census block, were developed. Connect Colorado also delivered similar maps for each region delineated by the Department of Local Affairs (DOLA). The Connect Colorado maps can be found at http://www.colorado.gov/cs/Satellite/OIT-New/OITX/1251568576242.

When viewing the broadband technology platform maps, it should be noted that in areas where multiple broadband providers offer service, the maps stack the display layers for broadband technology platforms in the following order, from top to bottom:

- Fiber
- Cable
- DSL
- Fixed Wireless
- Mobile Wireless
- Unserved

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That is, layers at the top of the stack cover lower layers. For example, in places where cable and DSL are both available, the map only shows cable service, which covers the DLS layer at those locations.

Further, when viewing the download speed maps, it should be noted that mobile wireless speeds are not included. Also, broadband speeds are displayed at the census block level, as opposed to the technology platform maps, which represent actual discrete broadband availability at a finer granularity based on the data from broadband providers. Therefore, there may be some discrepancy in the geographic depiction of the speed and coverage information in these two map sets.

Finally, although satellite-delivered broadband service is not depicted on the maps, it should be noted that it is available throughout the state.

Data and Demographic Analysis

One objective of this project was to analyze characteristics and patterns of population served, and unserved, by broadband. The first step in the analysis involved identifying the number of households with broadband service available to them. The results of this analysis are shown in the table below in terms of the percent of households in each county with broadband availability. These percentages are relative to household counts from the 2000 census and do not include mobile wireless, which is not typically included in household availability analyses.

County	Availability	County	Availability	County	Availability
Adams	99.69%	Fremont	87.81%	Montrose	90.85%
Alamosa	99.79%	Garfield	91.26%	Morgan	99.14%
Arapahoe	99.69%	Gilpin	93.42%	Otero	90.17%
Archuleta	84.58%	Grand	80.54%	Ouray	95.25%
Baca	93.38%	Gunnison	81.08%	Park	79.46%
Bent	96.44%	Hinsdale	71.92%	Phillips	97.61%
Boulder	99.19%	Huerfano	75.81%	Pitkin	87.40%
Broomfield	*	Jackson	70.82%	Prowers	99.18%
Chaffee	86.35%	Jefferson	99.55%	Pueblo	98.21%
Cheyenne	85.59%	Kiowa	84.59%	Rio Blanco	79.48%
Clear Creek	92.57%	Kit Carson	94.30%	Rio Grande	92.02%
Conejos	96.84%	Lake	80.65%	Routt	84.68%
Costilla	96.31%	La Plata	90.62%	Saguache	73.60%
Crowley	79.87%	Larimer	97.95%	San Juan	76.75%
Custer	55.57%	Las Animas	78.27%	San Miguel	74.95%
Delta	97.08%	Lincoln	77.55%	Sedgwick	90.25%
Denver	99.96%	Logan	98.03%	Summit	94.14%
Dolores	75.36%	Mesa	95.92%	Teller	80.11%
Douglas	98.70%	Mineral	62.63%	Washington	84.04%
Eagle	92.86%	Moffat	84.48%	Weld	98.84%
Elbert	79.08%	Montezuma	86.40%	Yuma	94.78%
El Paso	99.09%				

*Broomfield County was created in 2001; household availability based on Census 2000 demographics.

Connect Colorado also analyzed population, median income, and the percent of the geographic area of the county not served by broadband. Data on total households and median income were collected from the U.S. Census Bureau during the 2000 Census. The results of these additional analyses are shown in Appendix A.

The broadband analysis results have been broken up into two categories: 1) aggregated broadband service areas not including mobile wireless and 2) aggregated broadband service areas including mobile wireless. As mentioned above, mobile wireless is not typically included in an analysis of household availability, but both analyses have been completed here to understand the statistical impact that mobile wireless has on the State of Colorado. In the tables in Appendix A, the first worksheet outlines the statistics for broadband service not

including mobile wireless and the second worksheet outlines the statistics for broadband service with mobile wireless included.

Analysis of unserved households and population is performed at the census block level in order to achieve the highest precision possible. The numbers of unserved people or households in each block are then aggregated to the county level to create the statistics shown in the Demographic Analysis Results Table in Appendix A. Population estimates at the block level are not available between census years. In order to perform a consistent analysis for 2007, population was estimated for each block by applying the same growth rate experienced by a county from 2000 to 2007 to each census block in that county.

The Demographic Analysis Results Table shown in Appendix A can be used as a metric to set goals and focus efforts on those counties that have significantly lower broadband availability. While the State of Colorado has a statewide household availability of 97.53 percent, not including mobile wireless broadband, there are still 15 counties with broadband availability of less than 80 percent. This points to the need for further investigation and analysis into the broadband needs of under-served and unserved communities, the potential for demand aggregation to spur enhanced deployment, federal and state funding opportunities, and policies to address gaps in coverage.

Geographic availability, measured by the area covered by broadband service, varies greatly depending on whether or not mobile wireless broadband service is included. Without mobile wireless broadband, the geographic availability amounts to only 33.26 percent for the State of Colorado. While this creates a large disparity between the household availability and the geographic availability, it efficiently captures the vast difference between the population centers in the state and the sparsely populated rural counties. Geographic availability greatly increases when mobile wireless broadband is included in the analysis, yielding a broadband serviced area of 72.16 percent statewide. This statistic may be misleading however, as a large portion of the area serviced only by mobile wireless is very sparsely populated and does not greatly increase the number of households currently served by broadband.

Another metric worth noting is household availability when counties are classified as urban, suburban, or rural, according to the Pew Research Center. Taking the broadband serviced households for each county and aggregating up to the classification level, the following results were calculated:

Classification	Number of Counties	Household Availability
Urban	7	98.97%
Suburban	10	98.80%
Rural	47	89.42%

As demonstrated in the table above, rural broadband availability is nearly ten percentage points lower than availability in urban and suburban communities. The results are consistent with what has been observed in other states where Connected Nation has been able to complete a demographic analysis of broadband-served households.

DATA VERIFICATION

Connect Colorado undertook several preliminary validation efforts to determine if the data gathered from broadband providers were accurate. However, it should be noted that these activities were intended to make general conclusions about the data since the project time period was not sufficient to conduct fully conclusive data validation measures. These efforts included:

- Gathering information from broadband consumers through interactive speed test web sites;
- Performing field tests of wireless broadband signals;
- Broadband "inquiries" for service information (from residents without service currently) through web sites; and
- Detailed "ground truthing" in pilot areas.

Web Based Speed Tests

In an effort to validate broadband data from the Connect Colorado project, speed test information was collected throughout the state. Speed tests provide speed information on the path taken through all networks (a provider's network as well as additional networks) a local machine must connect to in order to reach the host test. This collection of speed information is two tiered. First, it allows for a comprehensive dataset of speeds, while also providing Connect Colorado with the information on where broadband services are available. Second, unlike theoretical speed information which was received through the data collection process, the use of speed tests provide real world information on the speeds that currently exist within Colorado. Preliminary results from the collected speed dataset demonstrated an average download speed of 5.1 megabits per second (mbps) and an average upload speed of 1.6 mbps.

Connect Colorado collected samples of actual consumer speed through the ConnectColorado.org site, and a marketing plan was developed to get citizens to test their broadband speeds and encourage as much input as possible. However, the primary source of information for this effort came from a partnership with Ookla Net Metrics and their SpeedTest.Net web site.

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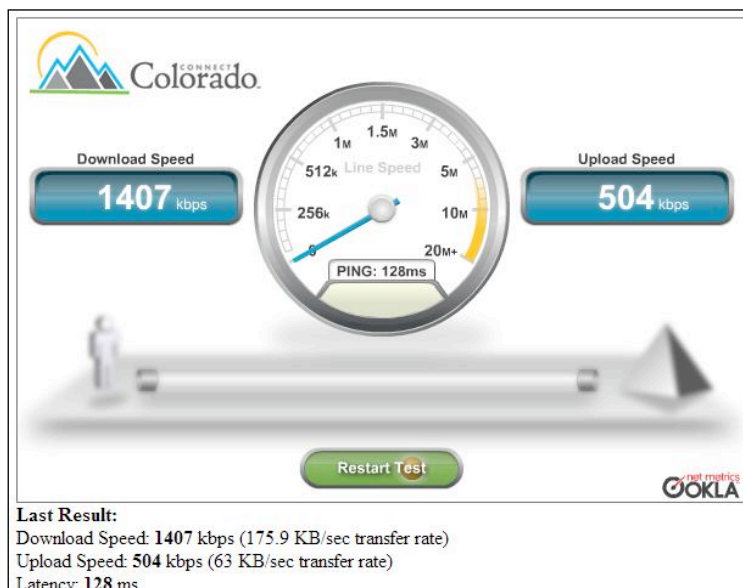
Data from nearly 270,000 speed tests was collected through the Connect Colorado web site and the result of the partnership between Connected Nation and Ookla Net Metrics. Due to the variability of geographic information collected across the speed test sites, the data from Ookla Net Metrics is geocoded utilizing Geo-IP technology. This technology allows for tests to be geocoded to points of aggregation, typically larger nodes across provider networks. While there are hundreds of thousands of tests that have been conducted, the level of aggregation is only sufficient for county level detail due to the test results being located at these larger nodes and not at an absolute location for each speed test.

Connected Colorado began with several hundred thousand speed tests from across the state, but eliminated outliers in the data through a process of qualifying the tests to ensure as accurate a depiction as possible. The following criteria were placed on the original data collection, resulting in the 269,742 tests:

- Limited the client-to-server distance to 400 miles or less
- Eliminated any test results that were not deemed residential
- Eliminated test results in which the speeds reported were dramatic outliers to the providers' advertised information

The table below illustrates the results from the speed tests, and the maps that follow depict where speed tests were received through the speed test web site. It should be noted that some counties either did not have a speed test conducted (meaning none of their residents used the Connect Colorado tools to check their speed) or in which the sample was insufficient for reporting. In these cases, the table indicates "no data" in lieu of actual upload and download speeds.

The FCC speed tiers referenced in the table are as follows:

- **First Generation Data:** Greater than 200 kbps but less than 768 kbps
- **Tier 1:** Equal to or greater than 768 kbps but less than 1.5 mbps
- **Tier 2:** Equal to or greater than 1.5 mbps but less than 3.0 mbps
- **Tier 3:** Equal to or greater than 3.0 mbps but less than 6.0 mbps
- **Tier 4:** Equal to or greater than 6.0 mbps but less than 10.0 mbps
- **Tier 5:** Equal to or greater than 10.0 mbps but less than 25.0 mbps
- **Tier 6:** Equal to or greater than 25.0 mbps but less than 100.0 mbps
- **Tier 7:** Equal to or greater than 100.0 mbps

COUNTY	FIPS	AVERAGE DOWNLOAD SPEED	FCC SPEED TIER	AVERAGE UPLOAD SPEED	FCC SPEED TIER
Adams	1	9129.39	Broadband Tier 4	3451.30	Broadband Tier 3
Alamosa	3	4551.85	Broadband Tier 3	1713.95	Broadband Tier 2
Arapahoe	5	8789.32	Broadband Tier 4	3449.90	Broadband Tier 3
Archuleta	7	2390.81	Broadband Tier 2	475.21	1st Generation Data
Baca	9	No Data	No Data	No Data	No Data
Bent	11	No Data	No Data	No Data	No Data
Boulder	13	8083.09	Broadband Tier 4	3250.75	Broadband Tier 3
Broomfield	14	7511.65	Broadband Tier 4	1892.01	Broadband Tier 2
Chaffee	15	3752.12	Broadband Tier 3	866.18	Broadband Tier 1
Cheyenne	17	No Data	No Data	No Data	No Data
Clear Creek	19	2919.99	Broadband Tier 2	1578.63	Broadband Tier 2
Conejos	21	1576.00	No Data	41.00	No Data
Costilla	23	No Data	No Data	No Data	No Data
Crowley	25	No Data	No Data	No Data	No Data
Custer	27	No Data	No Data	No Data	No Data
Delta	29	No Data	No Data	No Data	No Data
Denver	31	7165.19	Broadband Tier 4	2560.08	Broadband Tier 2
Dolores	33	No Data	No Data	No Data	No Data
Douglas	35	8718.14	Broadband Tier 4	3362.74	Broadband Tier 3
Eagle	37	7025.57	Broadband Tier 4	1683.78	Broadband Tier 2
Elbert	39	No Data	No Data	No Data	No Data
El Paso	41	5635.85	Broadband Tier 3	2478.45	Broadband Tier 2
Fremont	43	5077.76	Broadband Tier 3	457.57	1st Generation Data
Garfield	45	5449.35	Broadband Tier 3	1771.67	Broadband Tier 2
Gilpin	47	No Data	No Data	No Data	No Data
Grand	49	4757.74	Broadband Tier 3	1470.40	Broadband Tier 1
Gunnison	51	4404.21	Broadband Tier 3	482.95	1st Generation Data
Hinsdale	53	No Data	No Data	No Data	No Data
Huerfano	55	No Data	No Data	No Data	No Data
Jackson	57	No Data	No Data	No Data	No Data
Jefferson	59	7235.33	Broadband Tier 4	2823.99	Broadband Tier 2
Kiowa	61	No Data	No Data	No Data	No Data
Kit Carson	63	No Data	No Data	No Data	No Data
Lake	65	No Data	No Data	No Data	No Data
La Plata	67	2447.60	Broadband Tier 2	847.59	Broadband Tier 1
Larimer	69	6581.23	Broadband Tier 4	2934.46	Broadband Tier 1
Las Animas	71	Not Enough Data	Not Enough Data	Not Enough Data	Not Enough Data
Lincoln	73	No Data	No Data	No Data	No Data
Logan	75	1076.23	Basic Broadband Tier 1	510.00	1st Generation Data
Mesa	77	4906.32	Broadband Tier 3	627.42	1st Generation Data
Mineral	79	No Data	No Data	No Data	No Data
Moffat	81	No Data	No Data	No Data	No Data
Montezuma	83	No Data	No Data	No Data	No Data
Montrose	85	3884.90	Broadband Tier 3	999.42	Broadband Tier 1
Morgan	87	3564.95	Broadband Tier 3	524.84	1st Generation Data
Otero	89	2863.53	Broadband Tier 2	498.68	1st Generation Data
Ouray	91	No Data	No Data	No Data	No Data
Park	93	1890.56	Broadband Tier 2	1258.62	Broadband Tier 1
Phillips	95	No Data	No Data	No Data	No Data
Pitkin	97	8111.53	Broadband Tier 4	2699.67	Broadband Tier 2
Prowers	99	4738.72	Broadband Tier 3	569.49	Broadband Tier 2
Pueblo	101	5614.14	Broadband Tier 3	3177.80	Broadband Tier 3
Rio Blanco	103	Not Enough Data	Not Enough Data	Not Enough Data	Not Enough Data
Rio Grande	105	No Data	No Data	No Data	No Data
Routt	107	Not Enough Data	Not Enough Data	Not Enough Data	Not Enough Data
Saguache	109	511.12	1st Generation Data	332.76	1st Generation Data
San Juan	111	No Data	No Data	No Data	No Data
San Miguel	113	4192.89	Broadband Tier 3	667.70	1st Generation Data
Sedgwick	115	No Data	No Data	No Data	No Data
Summit	117	7945.73	Broadband Tier 4	2438.28	Broadband Tier 2
Teller	119	2987.85	Broadband Tier 2	719.69	1st Generation Data
Washington	121	No Data	No Data	No Data	No Data
Weld	123	7569.30	Broadband Tier 4	3334.22	Broadband Tier 3
Yuma	125	No Data	No Data	No Data	No Data

Broadband Service Inventory and Speed Test Data for the State of Colorado

OIT
Office of Information Technology

Colorado
CONNECT

Symbology

- Speed Test Location
- County Boundary
- Broadband Available
- Unserved Areas

N

0 5 10 20 30 40 Miles

Collected Speed Test Information

Colorado
CONNECT

Symbology

- County Boundary
- No Speed Test Data Collected
- Speed Test Data Collected

N

0 5 10 20 30 40 Miles

Through these speed tests, Connect Colorado was able to estimate the actual download and upload speed for counties in which speed test data was available. One additional caveat related to these estimates is that they reflect the subscribed speeds of the consumers who submitted speed tests. That is, if a provider offered a high speed service, but a particular consumer subscribed to a slower speed, the slower speed is what is accounted for in the speed test results.

While speed test information can be used for data validation, it is premature at this time to make final conclusions based on the above described data. First, despite the high number of speed tests across the state, there were still some counties that either did not have a speed test conducted or in which the sample was insufficient for reporting. However, citizens are still able and encouraged to check their connection speeds at www.connectcolorado.org. Continued testing and data collection will help to build a more robust data set and develop a clearer picture of actual versus theoretical broadband speeds.

Second, individual speed tests collected do not indicate what type of service the consumer was using (i.e. possibly not the highest speed package available from a given provider). Therefore, it was not possible in these cases to check the speed tests against provider-supplied data.

Validation of Broadband Availability Through Broadband Inquiries

The Connect Colorado website includes a citizen feedback tool to facilitate the validation of provider-reported broadband data and the potential expansion of services. "Broadband Inquiries" provide three types of information:

1) Residents who do not have broadband but want it.
2) Residents who have broadband but want a different provider.
3) Residents who believe they do not have access to broadband, but the Connect Colorado maps indicate that they do.

The collection of broadband inquiries supports a visual depiction of demand for broadband, which allows Connect Colorado the ability to validate broadband availability maps for accuracy. Once broadband inquiries are received across the state, this information can be overlaid with the broadband availability information collected by Connect Colorado allowing for a real-world comparison of the broadband landscape to the information received from broadband providers. If residents within a region state that they are without broadband, but the broadband inventory maps show otherwise, this allows Connect Colorado to approach the providers within that area in an effort to trim down their coverage to more accurately represent real world broadband availability on the ground. On the other hand, if there is a region in the state in which broadband is not available, broadband inquiries allows providers close to that region to see where they can successfully expand their broadband networks (leading to a high return on investment). In short, the higher number of inquiries leads to a higher level of certainty in regard to the broadband availability maps.

The broadband inquiry process has been implemented in several other Connected Nation state programs with successful results. Citizens in the State of Tennessee have submitted over 10,000 broadband inquiries since 2007, allowing the Connected Tennessee program to evaluate each inquiry for broadband demand and data verification. These inquiries are continuously examined against current broadband availability, updated every three months, to determine if previously unserved households have been expanded to and can now receive broadband access at their residence. This database of broadband inquiries has also allowed Connected Tennessee to aggregate demand in concentrated areas to show providers the exact locations where the population has made it clear that they would purchase broadband if it was made available to them. Providers in the state have responded to this process and have expanded to areas knowing that their investment will be worthwhile. Data verification methods have also proven successful, as Connected Tennessee has been able to show those inquiries that indicate the broadband service areas are misrepresented on the map to providers, who then verify where service cannot reach in regard to that residence. The broadband coverage in Tennessee has been altered to create a more accurate map based on the inquiries submitted by the public.

To date, the Connect Colorado project has received a total of 38 inquiries, out of which 10 of these inquiries are located within areas of no service. As more inquiries are submitted through the Connect Colorado website, a more thorough validation of the broadband landscape can be performed, while also allowing providers to see which areas have a high demand for broadband adoption. Citizens are encouraged to participate at www.connectcolorado.org.

Broadband Service Inventory and Broadband Inquiry Data for the State of Colorado

OIT
Office of Information Technology

Connect **Colorado**
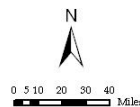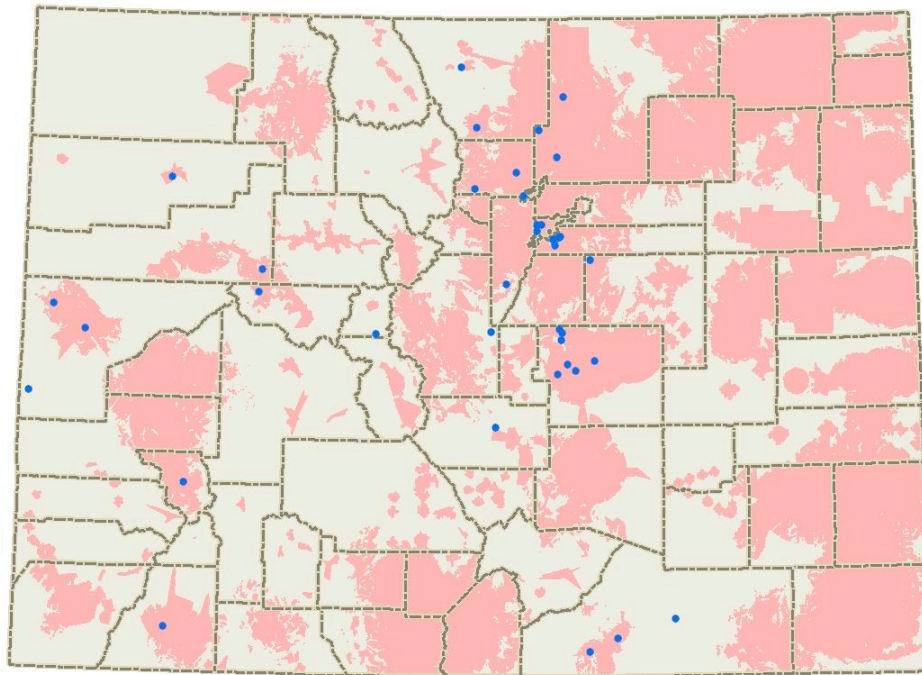
Symbology

- • Broadband Inquiry
- ▢ County Boundary
- ▮ Broadband Available
- ▯ Unserved Areas

N

0 5 10 20 30 40 Miles

The representations contained herein are for informational purposes only. Best efforts are undertaken to insure the correctness and accuracy of this information. However, all warranties regarding the accuracy of this map and any representation or inferences derived therefrom are hereby expressly disclaimed. Connect Colorado and its partners neither assume nor accept any liability for the accuracy of these data. Those relying upon this information assume the risk of loss exclusively for any potential inaccuracy. All errors and omissions brought to the attention of Connect Colorado will be promptly corrected.

This report includes important baseline data, but the broadband coverage percentages stated herein will need to be conclusively validated through additional speed tests and broadband inquiries and through citizen use of the interactive web map to report data inaccuracies. These tools can be access at www.connectcolorado.org.

"Ground Truthing" Pilot Study

While broadband mapping is often considered the critical first step to greater broadband deployment and adoption, there is little doubt that a map, void of supporting research and data, is simply a snapshot in time. The derivatives of a well planned research project, however, continue to pay dividends, inform decision making, and impact lives.

Connect Colorado was commissioned by OIT to conduct research in three Colorado counties impacted by the development, production, or conversion of energy and mineral resources. For those living in energy-impacted areas, some of which are sparsely populated, the internet's promise and potential is great. However, some rural Coloradans – including those living in energy-impacted areas – still lack access to broadband internet. Without this critical infrastructure, constituents living in remote regions of the state are unable to take advantage of the internet's many powerful benefits that would enable their communities to thrive during and after the energy boom years.

The potential counties that fit the initial criteria were identified as Moffat, Routt, Rio Blanco, Garfield, Mesa, Las Animas, La Plata, and Weld County. In order to ensure that the population density and demographic variability among the three areas remained a priority, Connect Colorado selected Weld (suburban), Garfield (exurban), and Las Animas (rural) Counties due to their distinct diversity.

Study Area	2007 Population	Pop. Growth 2000-2007	2007 Pop. Density (ppl/sq mi)	# Cities	Elevation Change	Per Capita Income
Garfield	53,303	21.7%	18	7	2,571	$21,341
Weld	249,299	37.8%	62.1	28	714	$18,957
Las Animas	15,804	3.9%	3.3	6	2,959	$16,829
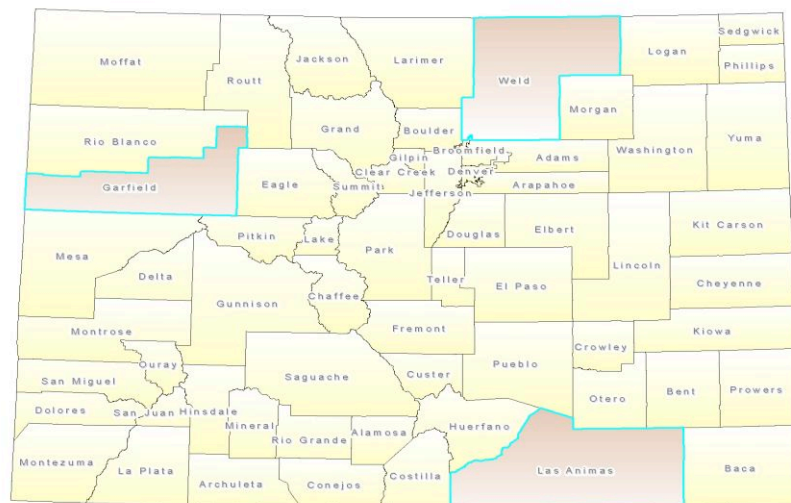
The contract between OIT and Connect Colorado set forth certain specific criteria to be incorporated into the Pilot Study. Connect Colorado was tasked with performing data validation tests to verify the accuracy of provider-reported data in the three pilot areas and to conduct interviews and surveys of residents and providers in order to evaluate the barriers to broadband adoption as identified by the individuals and/or communities in the pilot areas, as well as the overall perception of broadband services within each Pilot Study county. The results of these objectives are detailed below.

Data Validation Activities

Connect Colorado engineering staff conducted "on-site" visits in each of the three counties in order to validate geographic coordinates and/or the physical addresses of network operation centers, cable television head-ends, remote terminals, and wireless transmit sites. Additionally, the engineering staff was able to identify households subscribing to wireless services and to conduct signal and speed tests for mobile broadband services through random testing using an AVCOM PSA-37XP spectrum analyzer. Site validation efforts for the broadband provider community focused on certain wireless ISPs, cable television, and telephone companies offering broadband services in Garfield, Weld, and Las Animas Counties.

In many cases, the engineering staff was granted access to the provider's network in order to conduct "on-net" speed tests.[3] In each instance the tests yielded results that met or exceeded the provider's advertised throughput speeds, meaning that actual versus theoretical speeds were aligned.

Validation visits allowed the engineering team to obtain access to and test connectivity from various wireline providers (example picture on the left) or wireless providers (example picture on the right).
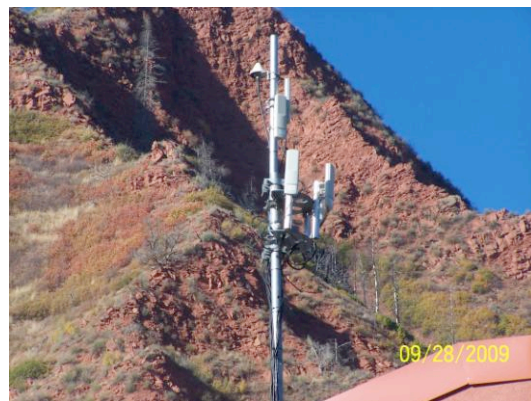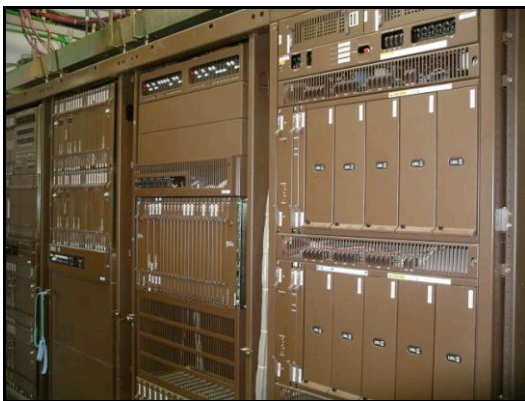
The engineering staff also conducted random throughput testing of mobile broadband coverage. By example, both spectrum analysis and throughput speed tests were conducted in areas where the mobile provider indicated that coverage should exist as well as within

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[3] These random, independent tests allowed the engineering team to compare advertised speeds against actual, onsite throughput tests.

locations identified as "fringe" or "marginal." Validation testing allowed for a simplistic "pass/fail" observation.

Whenever a wireless signal was detected from either a mobile wireless or fixed wireless provider and if a connection could be established, the engineers would conduct a real time speed test on the network. For mobile testing, a smart phone utilizing SpeedTest.Net (developed by Ookla Net Metrics) was used to determine if the mobile broadband service met the minimum threshold for broadband of 768 kbps download speed and 200 kbps upload speed. In the sample shown below, the test indicated that the mobile coverage delivered services above the standard threshold with a positive test of 900 kbps x 320 kbps. Accordingly, the spectrum analyzer verified the appropriate signal level and quality while the speed test itself yielded a test result of "pass."
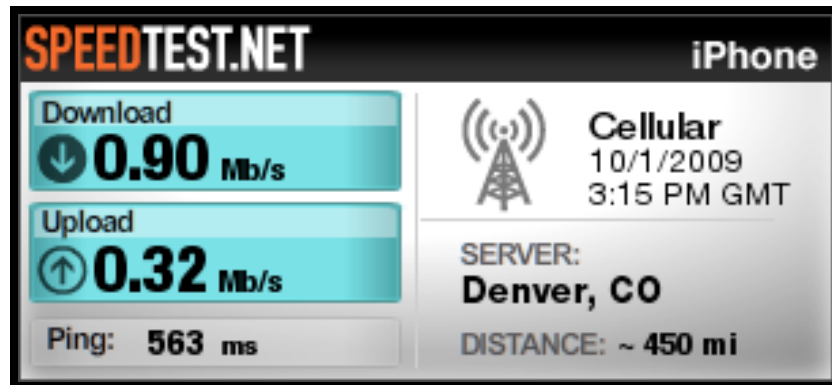
The illustration below is a sample speed test taken at the Trinidad Community Center in Las Animas County, Colorado. It demonstrates a throughput speed of 2,473 kbps x 1,162 kbps. This also received a "pass" indicating that that the broadband service performed consistently at or above the provider's advertised throughput rate.
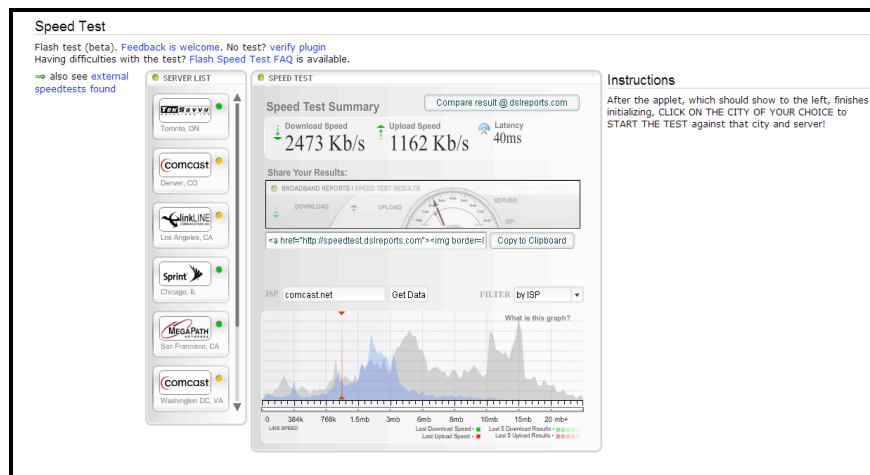
The AVCOM PSA-37XP spectrum analyzer also allowed the engineering staff to (i) locate wireless signals that may indicate the presence of a nearby Wi-Fi system; and (ii) validate the actual spectrum used by the Wi-Fi provider. The spectrum analyzer snapshot (shown below) was taken in Raymer, Colorado, and illustrates the existence of a fixed wireless signal at the

24

specific frequency of 2413.5 MHz, with a robust signal measurement of -71 dBm indicating that a connection to this Wi-Fi service would produce maximum results for the subscriber.
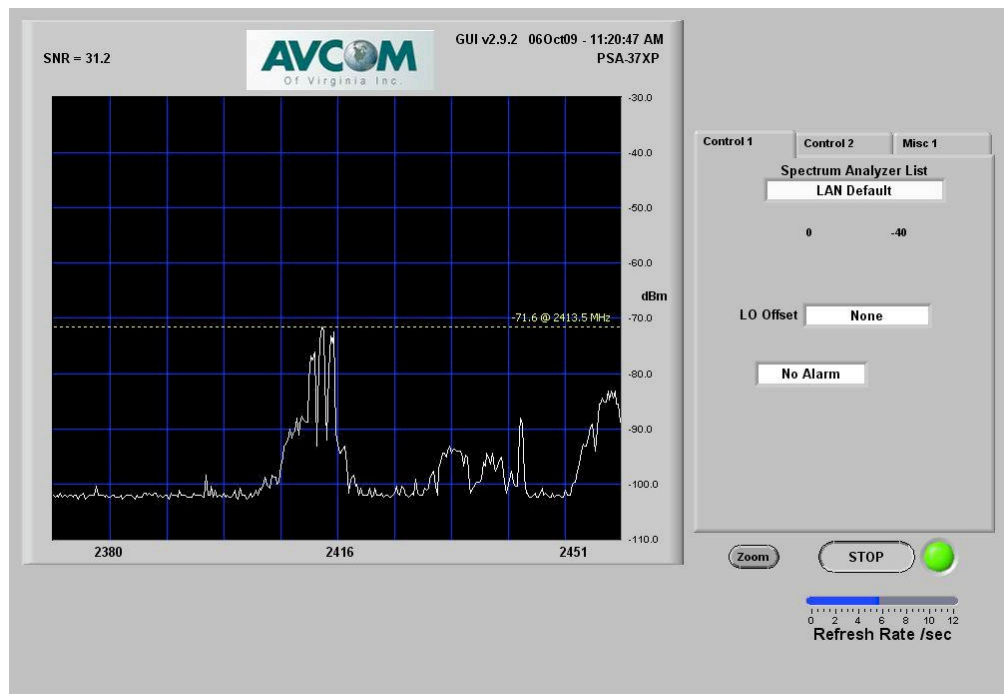
In all random test cases the provider's coverage was verified and deemed to be reasonably accurate. The engineering team estimates that approximately 30 percent of the broadband provider community in the three Pilot Study counties was subjected to such random testing.

Community Surveys

Collectively, Connect Colorado interviewed 19 broadband providers, 37 civic and community groups, and 442 residents throughout the three defined counties. The community and civic support was strong and most not only enthusiastically embraced the program but also provided additional survey distribution assistance. Many communities and organizations linked the pilot survey to their websites. There was widespread e-mail distribution to public and private membership lists, media exposure by newspapers, radio stations and newsletters, and citizens of one town stuffed survey notices in utility bills. All were excited about the prospect of broadband network enhancements to provide more robust services.

Door-to-door activity yielded the following results:

County	Homes Visited	Not Home No Answer	Not Interested	No Internet	No Soliciting	Complete Online Survey	Already Contacted via Phone	Completed Survey
Garfield	98	61	9	1	4	14	1	8
Las Animas	96	62	24	0	0	1	0	20
Weld	82	38	16	0	0	0	0	28

Telemarketing activity yielded the following results:

County	No Answer	Disc. Number	Wrong Number	Busy Signal	No English	Answering Machine	Not Interested	Completed Survey
Garfield	33	20	25	6	10	72	40	25
Las Animas	47	28	5	3	0	74	49	24
Weld	3	0	4	0	0	17	7	6

Supporting activities (town hall meeting, provider meetings, community meetings et al) yielded the following completed survey forms:

County	Town Hall	At Work	Man On The Street	Online Surveys
Garfield	8	5	13	46
Las Animas	0	0	0	28
Weld	0	0	0	69

The research survey conducted in these counties produced noteworthy results. The Pilot Study survey set out to evaluate barriers to broadband adoption as identified by the individuals and/or communities in the pilot areas as well as the overall perception of broadband services within each Pilot Study county. The figures below show some of the results from the 280 surveys that were completed.

Technology Adoption Summary

N=279 residents of Garfield, Las Animas, and Weld Counties. The chart illustrates first the percentage of respondents that own a computer (green), then by respondents indicating that they subscribe to the Internet (including dial-up) at their home (yellow) and, finally the sub-set of respondents indicating that their Internet service meets the FCC definition of broadband.

The chart above infers that computer ownership across the three counties is relatively high with the lowest percentage in rural Las Animas County. This suggests that efforts to increase computer ownership in at least some parts of Colorado may be necessary. Another interesting result is the variation in adoption percentages between internet and broadband, indicating a higher usage of "dial-up" than might have been expected.

Barriers to Home Broadband Adoption

Barrier	Percentage
Broadband is not available in my area	68%
Too expensive	64%
Concerns about fraud or identity theft	16%
I don't need broadband	12%
The broadband service offered where I live is not fast enough to be worthwhile	8%
I can access broadband someplace else	4%
Other	20%
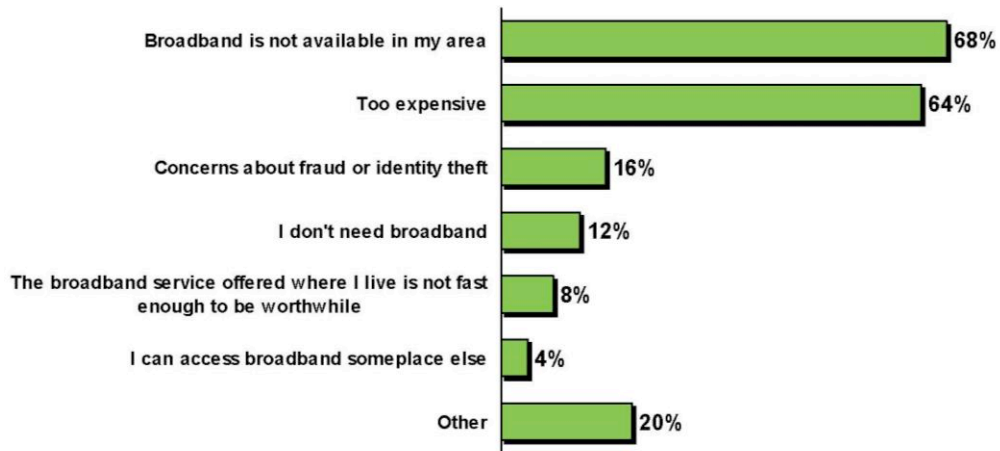
N=44 residents of Garfield, Las Animas, and Weld Counties with no home broadband service
Figures do not add up to 100% because multiple responses could be given.

Broadband pricing was indicated as a significant barrier to adoption for at least half of the survey respondents, which highlights the need for additional cost analyses and possibly policy strategies to address this particular adoption obstacle. For reference, the chart below provides a sampling of cost data across the three pilot counties.

Monthly Price County Residents Pay for Internet Service
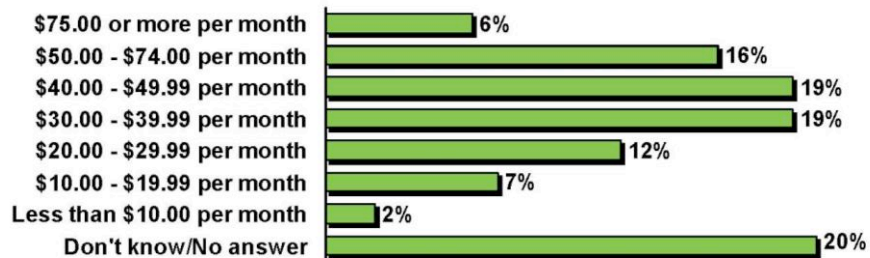
Price Range	Percentage
$75.00 or more per month	6%
$50.00 - $74.00 per month	16%
$40.00 - $49.99 per month	19%
$30.00 - $39.99 per month	19%
$20.00 - $29.99 per month	12%
$10.00 - $19.99 per month	7%
Less than $10.00 per month	2%
Don't know/No answer	20%

N=279 residents of Garfield, Las Animas, and Weld Counties

Awareness of Available Broadband Service

Subscribe to home broadband service, or know broadband is available where they live
75%

Not aware of broadband service available where they live
11%

Don't know, or no response
14%
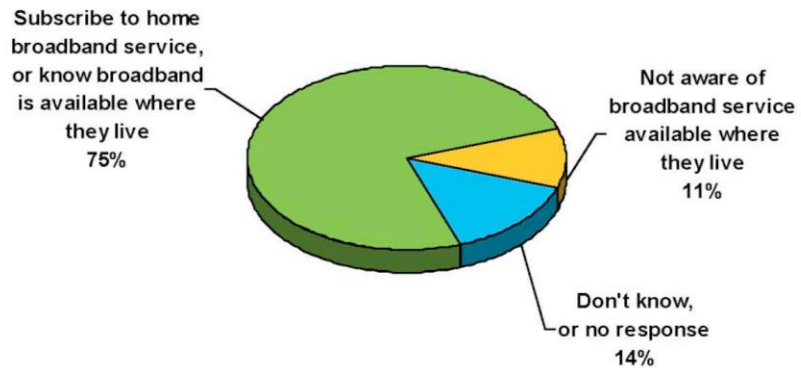
N=279 residents of Garfield, Las Animas, and Weld Counties

Awareness of Available Broadband Service by County

Percent of respondents who are aware of broadband service available where they live, or who already subscribe to home broadband service

75%	78%	55%	84%
Pilot Study Average	Garfield County	Las Animas County	Weld County
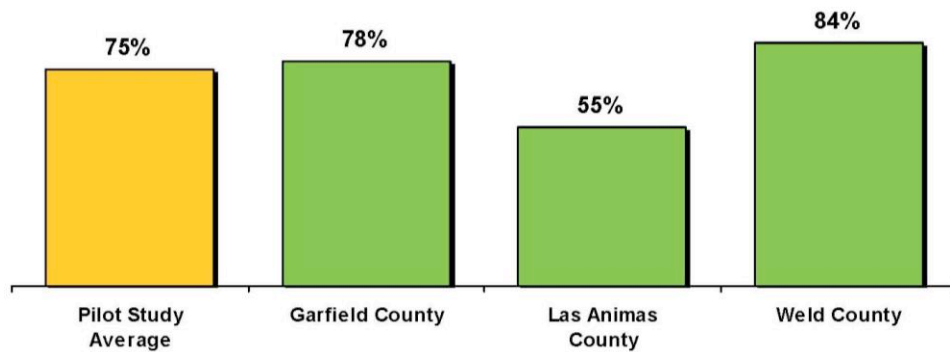
N=279 residents of Garfield, Las Animas, and Weld Counties

More information is needed to determine if the lack of awareness of broadband is related to deployment, provider marketing, or general education/outreach. However, 25 percent is a sizable figure and suggests that further investigation and analysis are warranted.

Satisfaction with Current Internet Service

Satisfied
64%

Not satisfied
33%

Don't know, or no response
3%

N=248 Internet subscribers in Garfield, Las Animas, and Weld Counties

Reasons for Dissatisfaction with Home Internet Service

N=81 Internet subscribers in Garfield, Las Animas, and Weld Counties
who are not satisfied with their current home Internet service
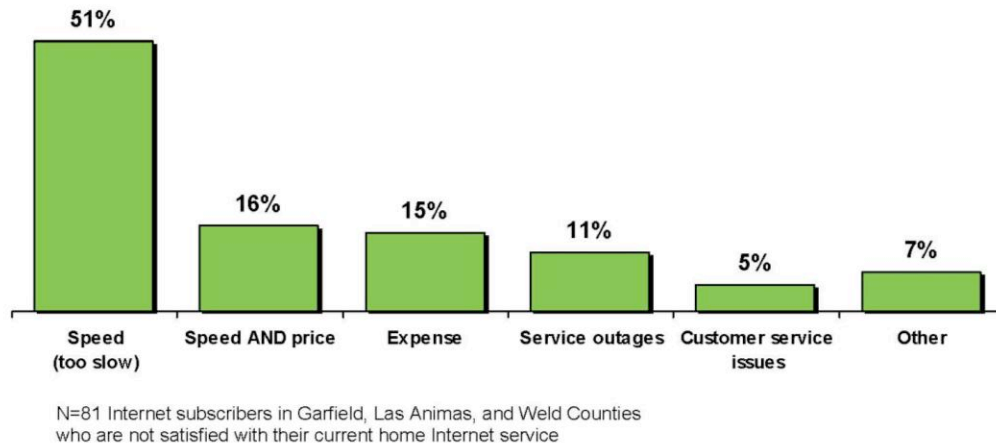
As mentioned in the introduction of the report, broadband speed satisfaction is a factor that should be considered along with basic deployment statistics. The survey indicates that citizens are requiring faster speeds to run the applications that are meaningful to them and that this should be an important part of the policy discussion going forward.

Reasons Colorado Residents Go Online

N=279 residents of Garfield, Las Animas, and Weld Counties
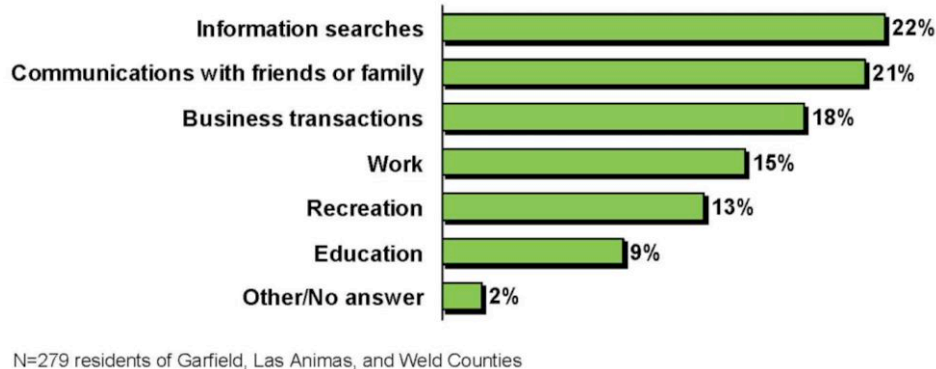
The final chart provides insight into the reasons some Coloradans use the internet. Applications critical to citizens will spur broadband deployment and associated bandwidth requirements. Policymakers will need to keep an eye toward the varying needs of the populace when developing broadband deployment and adoption strategies.

Pilot Study Results

Connect Colorado found widespread broadband service across each of the counties. As the team moved from Weld to Garfield to Las Animas counties, they observed fewer provider options for constituencies, and fewer options typically meant slower speeds. These conditions generally existed to a greater degree in the rugged rural areas of western Las Animas County and in both the northern and western regions of Garfield County. Any reasonable density of homes in Weld County was found to have at least one local broadband

provider, in addition to satellite delivered broadband services. Most rural communities had multiple fixed wireless providers and some also had access to DSL and fiber to the home (FTTH).

Though Weld County has near ubiquitous broadband coverage, one reported problem was insufficient access to high-capacity backhaul outside of the major population centers. Instances currently exist where a broadband provider has deployed 100 mbps fiber to the home, yet must rely on bundled T1's[4] as the single source of backhaul. The study found backhaul to be an important issue for broadband providers, who reported both backhaul access and some pricing concerns. Conversations with governmental agencies, libraries, and school districts pointed to the desire for higher speeds at lower cost, while discussions with providers revealed the need for higher capacity at lower costs. The Pilot Study results support the need to fully assess the magnitude of backhaul availability, capacity, and pricing issues and to identify ways to overcome this broadband deployment obstacle.

Although the Pilot Study only provides insight into the broadband landscape of three Colorado counties, it is a valuable starting point for further exploration into the issues that are affecting broadband deployment and adoption across Colorado. The Obstacles to Broadband Development section below takes the discussion statewide by providing the results of a broader web-based survey and offering a deeper analysis of broadband development obstacles.

Data Validation Conclusions

While some preliminary validation and "ground truthing" of the broadband availability data was performed by Connect Colorado, OIT is aware that time and budgetary factors did not allow for this validation to be comprehensive across the entire state or even to a statistically rigorous level of detail within areas identified as receiving a particular broadband service. As a result, there may be pockets of areas lacking broadband service of a specific kind within broad areas delineated as being served. In addition, each specific technology platform was not comprehensively verified across its designated area in the state. That said, the validation performed provided a good indication of the issues that might arise and allows OIT to design a more informed validation process in future efforts. In fact, OIT has been awarded a $2.1 million ARRA grant from the NTIA for future broadband data collection and mapping efforts, a significant portion of which will support staff for independent testing and validation of broadband availability data.

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[4] A T1 line can carry data at a rate of 1.544 megabits per second (Mbps).

OBSTACLES TO BROADBAND DEVELOPMENT

Overview of Broadband Usage by Colorado Citizens

In addition to the Pilot Study which examined adoption barriers and revealed general perceptions of the internet for three counties in Colorado, Connect Colorado conducted a web-based assessment to gauge how citizens are using the internet, where they are getting online, and what prevents them from connecting, thereby facilitating future plans to help citizens get connected and use broadband to their advantage.

The sample size for this survey was 110 respondents who verified their responses with an e-mail address and who reported that they were residents of one of Colorado's counties. Due to the self-selective nature of the online survey, as well as the possible potential bias resulting from asking questions about internet adoption through an online survey, the percentages shown are not meant to be a representative sampling of the State of Colorado as a whole. The un-weighted percentages that Connect Colorado reports merely reflect the percent of respondents who gave each response to the questions asked. This is not reported as a scientifically valid sample of the state as a whole but rather serves as a jumping off point for future policy discussions.

The charts below summarize the results of the assessment. It should be noted that figures do not add up to 100 percent because multiple responses were possible.

Where Colorado Internet Users Go Online

Location	Percentage
Home	85%
Work	66%
Library	25%
Restaurant or coffee shop	24%
Hotel	20%
Airport	19%

31

12%

4%
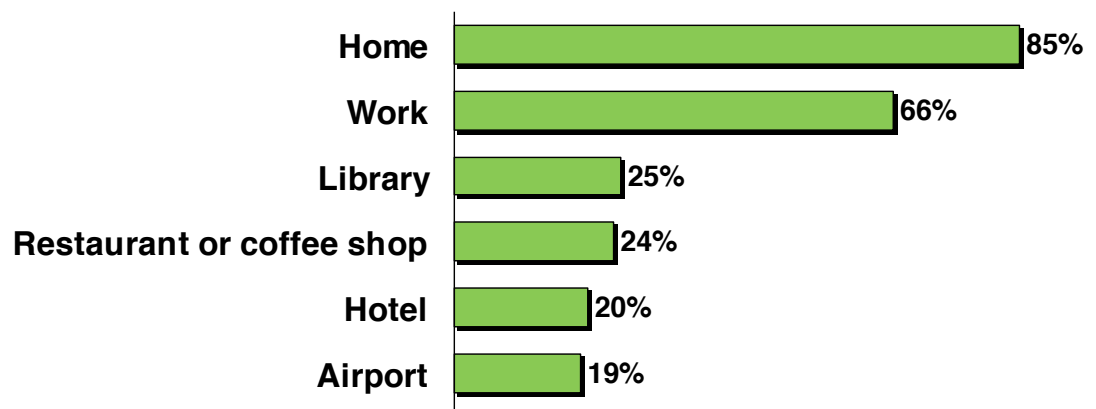
Reasons for Subscribing to Home Broadband Service:
Colorado broadband subscribers who report that these factors were
"very important" in their decision to subscribe to home broadband service

Factor	Percentage
Needed to conduct business online	46%
Realized broadband was worth the added cost	41%
The cost of broadband became more affordable	37%
Broadband became available where they lived	32%
Purchased or received a new computer	18%
Learned about the benefits of broadband	13%
Convinced by a friend or family member	5%
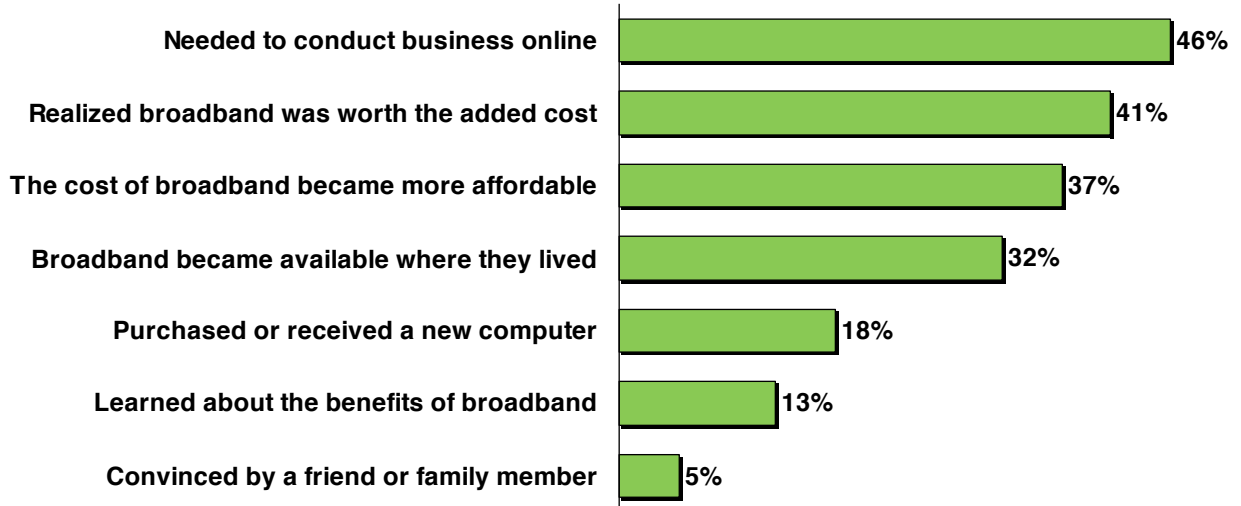
Searching for Information Online:
Colorado internet users who report searching for these
types of information at least several times per week

Type of information	Percentage
Product or service information	61%
Information about community events	36%
Information about government services or policies	21%
Research for schoolwork	18%
Jobs or employment	15%
Health or medical information	11%
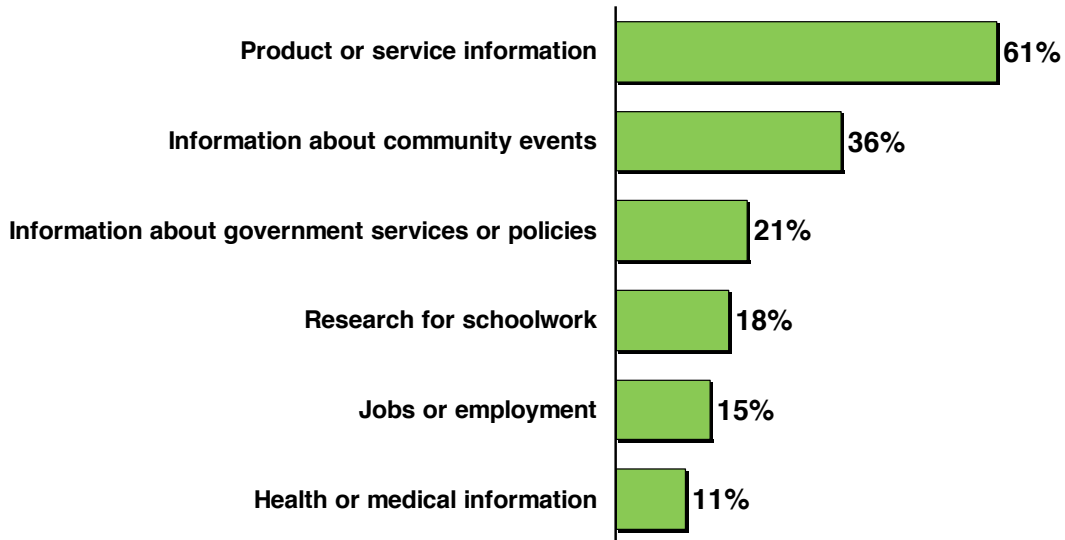
Communicating Online:

Colorado internet users who report communicating in the
following ways at least several times per week

E-mail	96%
Through a social networking site	48%
Instant messages	34%
Posting content to a website	17%
Posting content to a blog	11%
Chatting in chat rooms	5%
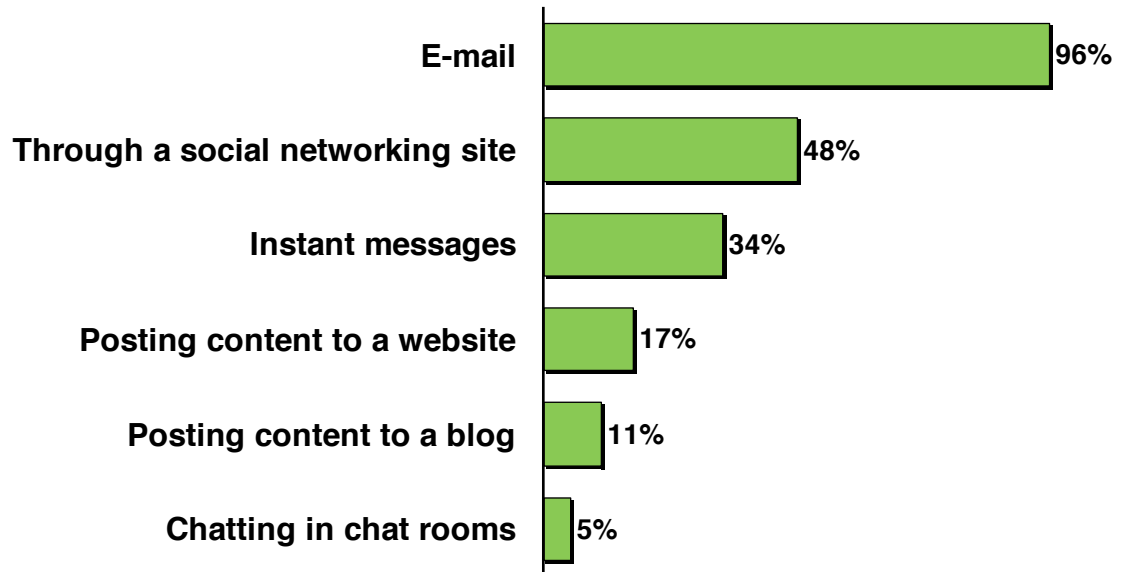
Online Transactions:

Colorado internet users who report conducting the following
online transactions at least several times per week

Online banking	53%
Paying bills	38%
Purchasing a product or service online	22%
Booking travel arrangements	6%
Online transactions with government offices	5%
Buying, selling, or trading investments	5%
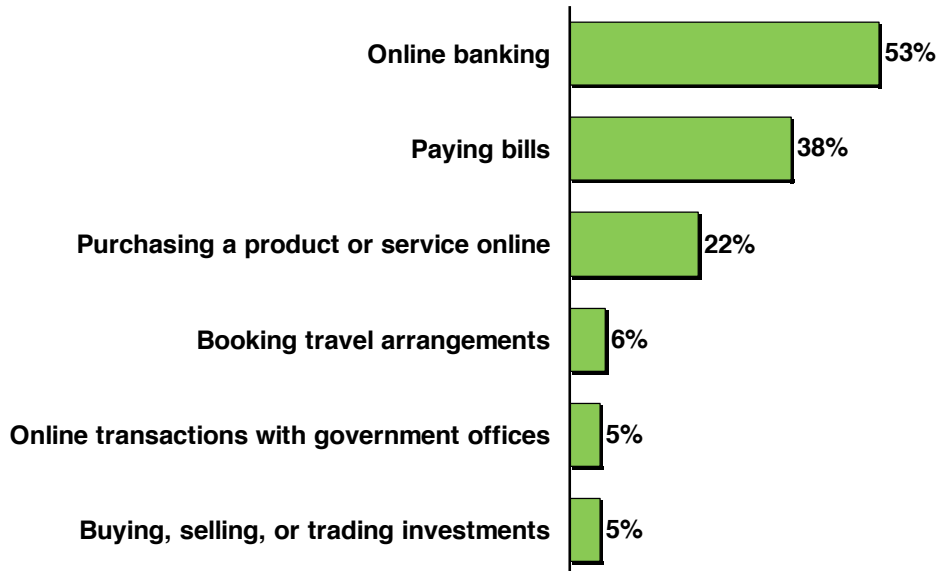
As stated above, the results cannot statistically be generalized to all Colorado citizens. However, they reveal that the internet is being utilized for a myriad of purposes, including obtaining information about public-sector services and engaging in online transactions with government offices. E-government opportunities are becoming increasingly prevalent, and the outcomes of the web-based survey suggest that citizens will continue to turn more and

more to the internet for government services important to their daily lives. This makes broadband deployment to all Colorado communities even more critical.

Certainly, the work does not stop with this project. Future broadband-related efforts will need to tackle the important issues of whether capacity is sufficient to run desired applications and whether service is affordable enough to enable citizens to engage. These questions will need to be answered to effectively develop and implement state policies.

Market Analysis and Barriers to Deployment

In addition to studying internet usage, Connect Colorado compiled a market analysis report to reveal information about the current market condition of the state and what may be inhibiting broadband deployment and adoption. The results provide insight based on the perceived barriers of the state, the current state of deployment, and the knowledge of several broadband engineers who have spent a significant amount of time on the ground in Colorado.

General market conditions throughout the state are characterized differently moving from county to county and within the varying regions of the state. In the mountainous parts of Colorado, there are many seasonal and vacation home situations that create an interesting market dynamic. Combining this attribute with unemployment concerns, and varying business climates, the result is a distinctly unique set of market conditions indigenous to each county of the state.

Resort towns (such as Vail and Breckenridge, etc.) see a significant rise in the seasonal population when ski slopes open in November. In these locations, there is also an increase in the number or persons utilizing the Wi-Fi systems in the area as well as the wireline services typically offered as amenities[5] in the resort lodges and surrounding hotels. While this anomaly boosts profitability for the internet providers, it does not improve the return on investment (ROI) model necessary to expand coverage into the exurban areas that are nearby.

Thus, sparse population densities (in the rural and remote area) immediately surface as the single largest barrier to broadband expansion within the state. Whether unserved or under-served this plays a significant role in determining a reasonable ROI model for any broadband provider. However, fixed wireless, satellite, and broadband cards connected to laptops were solutions adopted by some communities surveyed by Connect Colorado. For example, of the three counties surveyed, Las Animas County (which has the lowest population density of the three) had the fewest choices overall of broadband providers and the highest incidence of satellite broadband subscription at 15.3 percent. This compares to 8.5 percent in Garfield County and 2.2 percent in Weld County.

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[5] Services may be included in the cost of the hotel or charged as an "add-on" to the consumer's bill. Typically, when a "pay-per-use" mechanism is in place, consumers are charged for incremental use (e.g. 1 hour, ½ day, 24 hours, etc.).

When looking specifically at the amount of coverage that is available in rural enterprise zones[6], one could draw conclusions that are/were based upon the potential funding structures for those zones. The geography for some of these zones might be ideal for developing zone-wide broadband deployments. Shown below are samples of the availability of services to households for selected rural Enterprise zones.

Enterprise Zone	Households Served	Total Households		Availability
East Central	6,010.1	7,696.0		78.09%
El Paso	59,804.5	60,984.0		98.07%
Greenly/Weld	18,245.1	18,571.0		98.25%
Mesa	42,501.1	42,833.0		99.23%
Northeast	24,922.2	25,825.0		96.50%
Northwest	26,596.9	31,242.0		85.13%
Pueblo	38,596.7	38,777.0		99.54%
Region 10	29,131.8	31,954.0		91.17%
San Luis Valley	16,043.8	17,328.0		92.59%
South Central	14,309.4	17,175.0		83.32%
Southeast	10,621.2	11,238.0		94.51%
Southwest	26,359.2	30,006.0		87.85%
Upper Arkansas	22,283.7	26,273.0		84.82%

Conventional wireline broadband deployment in the state's rural areas does not always present a reasonable ROI. While it is possible for the incumbent local exchange carrier to install digital subscriber line access multiplexers (DSLAMs) for costs at or below $50,000 per remote terminal, doing so in locations where there are less than 100 serviceable households may present less than desirable ROI expectations. Similar circumstances exist in cases where the cable television (CATV) operator is considering data over cable service interface specification (DOCSIS) but low household densities impede expansion.

Fixed wireless broadband, on the other hand, presents a logical opportunity for additional coverage in Colorado, even in sparsely populated areas (although as mentioned previously resolving backhaul issues could also increase coverage). Fixed wireless is currently being used on a wide scale throughout the state to provide broadband services to the citizens of Colorado. What wireless technology cannot overcome is the mountainous terrain and perceived lack of reasonably priced backhaul access to the internet. In certain instances it is apparent that even fixed wireless deployments in some of the state's more remote regions (i) cannot be easily justified; and (ii) in many cases, when combined with backhaul issues, can sometimes be overly costly to be a plausible deployment mechanism. Satellite-delivered service can be another logical option for broadband coverage expansion.

Below is a map depicting potential infrastructure (such as broadcast towers) that could be utilized to provide services into those areas of the state that are currently unserved. There are approximately 1,200 towers registered with the FCC for the State of Colorado and, of those,

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[6] Colorado's Enterprise Zone program provides tax incentives to encourage businesses to locate and expand in designated economically distressed areas of the state. There are 16 Enterprise Zones and 2 sub-zones in Colorado.

approximately 214 of them are outside of traditional broadband coverage areas. The vast majority of these "vertical assets" can be identified using publicly available information sources (e.g. FCC Antenna Structure Registration database located on the web at: http://wireless.fcc.gov/antenna/index.htm?job=home).

FCC Towers and Broadband Service Coverage for the State of Colorado

Submit questions or recommended changes to: maps@connectednation.org
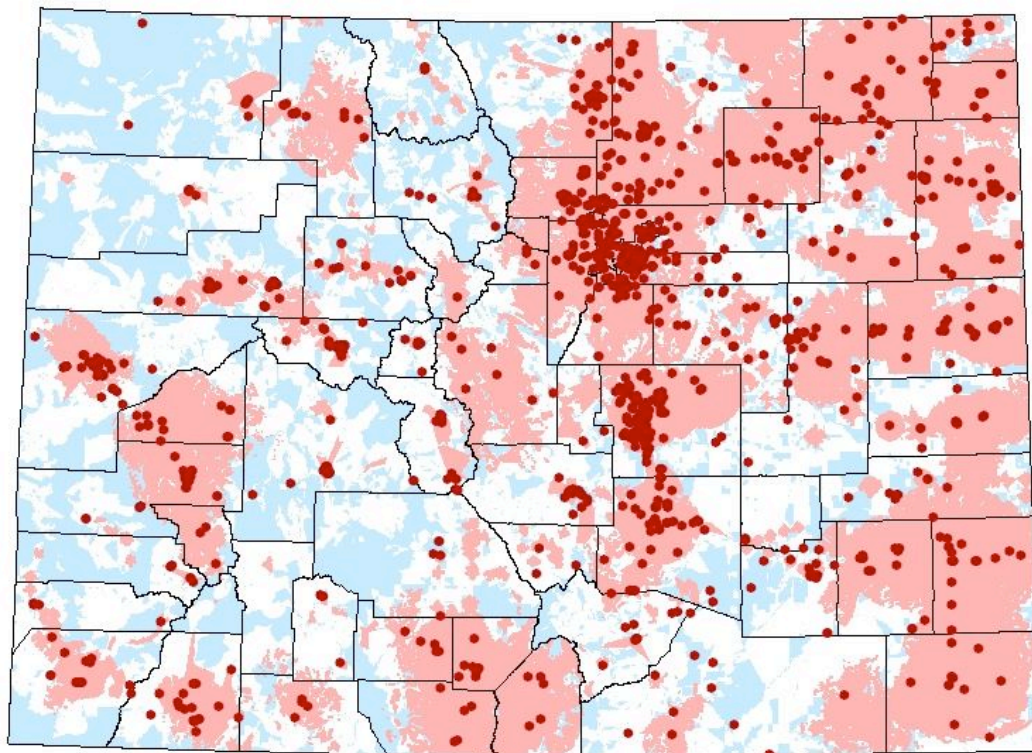
- • FCC Tower
- —— County Boundary
- Broadband Availability
- Census Blocks with No Households

It should be noted that tower structures do not always require registration with federal or state agencies. Typically, the FCC ASR database only contains information for towers that are in excess of 200 feet or are situated in a "flight zone." Thus, a large number of vertical assets in Colorado may fall into this unregistered category. These unidentified vertical assets can often be instrumental in the development of a robust fixed wireless system and could take the form of an elevated water tank, communications towers erected at county E-911 facilities, studio-to-transmitter link towers situated on the campuses of the state's vast number of colleges and community colleges, grain elevators, grain silos, and a host of tall buildings in any Colorado town.

There are several areas of the state that literally do not have any households in them. As such the map helps to inform and demonstrate exactly how spread out the population is within the state.

Connected Colorado focused resources across Colorado to collect and analyze data to gain an understanding of the broadband landscape as it exists today. This includes, but is not limited to, extensive research time in the Pilot Study counties of Garfield, Weld and Las Animas Counties. Several notable factors were identified that present immediate issues for the continued development of broadband systems within the state and the adoption of such services once deployed. The report attempts to reasonably identify and provide insight into the barriers facing broadband providers in the State of Colorado. However, it should be noted that future efforts are warranted to quantify the magnitude of these barriers and identify appropriate solutions.

Technology

The primary technological hurdles identified through Connect Colorado's field work are centered on (a) the availability, or lack thereof, of necessary infrastructure (backhaul); and/or (b) the additional transport of that infrastructure to locations in need of last mile services. In many instances providers that were interviewed noted that while infrastructure was generally existent in the immediate area (a) backhaul circuits were often times not located where they could be easily accessed (due to the distance from the closest network point-of-presence; or (b) in some cases the infrastructure resided on private property with no right of access. As mentioned above, instances currently exist where a broadband provider has deployed 100 mbps fiber to the home, yet must rely on bundled T1's as the single source of backhaul.

Financial Opportunity

As previously mentioned, the incumbent local exchange carrier can install DSLAMS for costs at or below $50,000 per remote terminal. However, it may not be fiscally responsible to do so in locations where there are less than 100 serviceable households. Similarly, low household density can impede broadband expansion efforts for CATV operators.

A technology with a low cost of entry, and a predominant last mile provider of low density service areas, is the unlicensed fixed wireless operator. Once the domain of the "Mom & Pop" operator, today there is noticeable industry consolidation, especially in Colorado. Fixed wireless broadband was noticeably present throughout the state. In situations where rural/remote communities or homes could obtain wireless broadband services, the wireless provider was often forced to use long distance wireless point-to-point (PTP) links. This allowed them to obtain reasonably priced backhaul circuits in metropolitan or suburban markets (e.g. Glenwood Springs) and transport it via PTP links to areas such as Silt or Parachute.

Demand

Through the pilot studies completed in Garfield, Las Animas, and Weld Counties, Connect Colorado was able to collect fundamental data regarding potential consumer barriers to broadband adoption within the state and formulate an analysis of what Colorado residents

have reported. Understanding these important issues could have a significant impact on the financial viability of broadband deployment and possible upgrades, particularly in rural, unserved areas of the state.

Topographical Barriers

Topographical barriers around the state are the main source for what is likely the biggest hurdle that the state faces in advancing the current broadband infrastructure. The vast variations in landscape morphology of the state have created very interesting population trends. Colorado's suburban and exurban population is dispersed in small pockets around the state, typically in open areas but often at the base of the nearby mountain range. Then, outside of these pockets, there are very sparsely populated areas. The data collected from broadband providers around the state indicate that 97.53 percent of the households in the state have availability of broadband services; however, only 33.26 percent of the geographic area of the state has broadband available. On average in the areas where broadband is available there is a household density of 44.17 households per square mile. In comparison to this number, for the areas of the state that do not have broadband available, the average number of households per square mile is equal to 0.59.

The rugged mountainous topography of the western half of Colorado has limited broadband providers to serving the populated pockets. Entrepreneurial companies with more relaxed ROI models (e.g., fixed wireless providers) have developed unique ways to overcome some of the topographical and population issues. This has led to an unusually widespread utilization of fixed wireless services throughout the state.

Although not necessarily a barrier to adoption, consumer satisfaction is certainly a key element in stemming customer migration. The Pilot Study showed a third of all respondents (32.7 percent) were dissatisfied with their provider. Primary reasons for lack of satisfaction were speed of service (67 percent), cost (31 percent), and service (17 percent). It should be noted that respondents were allowed more than one answer.

CONCLUSION AND NEXT STEPS

Some view broadband as the electricity of the 21ˢᵗ century. The technology is becoming increasingly necessary to conduct business, utilize government services, communicate with friends and family, perform research, and shop for products. In order to ensure Colorado citizens are able to take advantage of the many uses for broadband, there needs to be an understanding of the current broadband footprint so that effective policy strategies can be developed and solutions can be implemented. Senate Bill 08-215 called for the development of such an inventory, and with the assistance of Connected Nation, the State of Colorado now has the baseline data from which to begin driving these policy discussions and ultimately catalyze broadband deployment, enhancement, and adoption efforts.

Data from the Colorado Broadband Mapping Project shows that over 97 percent of Colorado households have broadband service of at least 768 kbps downstream and at least 200 kbps upstream. When the figure is taken out of context, it appears that Colorado has reached near ubiquitous coverage. However, the number is only one piece – although an important piece – of the larger broadband puzzle. Broadband capacity (i.e., speeds) and adoption, as well as rural disparities, must also be considered before reaching any final conclusions.

Basic broadband speeds will allow certain applications to be utilized, but enhancing current infrastructure deployment in many communities will certainly be necessary for residents to take advantage of important online services. Further, outreach and education campaigns are necessary to demonstrate to citizens the importance of broadband to their everyday lives. Finally, policymakers will need to focus deployment efforts on those communities that lack even basic broadband coverage.

As mentioned several times throughout the report, this project is only a starting point to help direct and target future broadband-related efforts. Barriers to broadband deployment (such as a lack of backhaul infrastructure) and barriers to broadband adoption (such as the cost of service) were identified through the Pilot Study and web-based survey portions of the mapping project; however, these topics need to be explored in greater depth in order to select the most appropriate course of action for the State of Colorado.

The Governor's Office of Information Technology has been awarded American Recovery and Reinvestment Act (ARRA) grant funds from the NTIA to continue its broadband data collection and mapping efforts and to help identify priority areas for activities to promote the deployment and use of broadband service. This project will compliment, build off of, and help to validate the findings of the Connect Colorado project. The grant funds will be used to collect a variety of data as required by the State Broadband Data and Development Grant Program administered by the NTIA. The data will include broadband service availability as well as middle-mile interconnection infrastructure, service available to "community anchor institutions" (i.e., education facilities, health care facilities, and government buildings), and average weighted speed over metropolitan or rural statistical

areas. OIT will also use these grant funds to develop additional demand-side information and work more closely with local technology planning teams and other community stakeholders to assess broadband adoption and market forces affecting it. OIT will continue to work with local, state, and federal leaders to transform the results of any broadband-related initiatives into well-informed policies and strategies.

In the meantime, citizens are encouraged to utilize the Connect Colorado web-based service as an educational tool and to document any inaccuracies in the current data. It is located at www.connectcolorado.org.

APPENDIX A

DEMOGRAPHIC ANALYSIS RESULTS TABLES

County	FIPS	Total HH 2000 Census	2007 Population Estimate	Median Income 2000 Census	Area in Square Miles	Broadband Covered HH (2000 Census)	County HH Availability	Unserved Households (2000 Census)	County HH Unavailability	Unserved Population (2007 Estimates)	County Population Unavailability	Median Income of Unserved (2000 Census)	Unserved Area in Square Miles	Percent of Total Area Unserved
Adams	001	128,156	424,379	$47,323	1,183.5	127,758.12	99.69%	397.88	0.31%	1,114.10	0.26%	$47,323	629.15	53.16%
Alamosa	003	5,467	15,760	$29,447	723.4	5,455.75	99.79%	11.25	0.21%	37.72	0.24%	$29,447	151.11	20.89%
Arapahoe	005	190,909	551,733	$53,570	805.6	190,310.23	99.69%	598.77	0.31%	1,624.99	0.29%	$53,570	469.73	58.31%
Archuleta	007	3,980	12,625	$37,901	1,354.6	3,366.46	84.58%	613.54	15.42%	1,501.50	11.89%	$37,901	1,106.57	81.69%
Baca	009	1,905	4,188	$28,099	2,557.1	1,778.90	93.38%	126.10	6.62%	328.00	7.83%	$28,099	848.64	33.19%
Bent	011	2,003	5,926	$28,125	1,541.2	1,931.65	96.44%	71.35	3.56%	181.36	3.06%	$28,125	558.32	36.23%
Boulder	013	114,680	294,654	$55,861	740.5	113,756.65	99.19%	923.35	0.81%	2,105.44	0.71%	$55,861	213.91	28.89%
Broomfield	014	*	53,691	*	33.4	*	*	*	*	*	*	*	*	*
Chaffee	015	6,584	16,942	$34,368	1,014.7	5,685.02	86.35%	898.98	13.65%	2,079.38	12.27%	$34,368	849.44	83.71%
Cheyenne	017	880	1,995	$37,054	1,781.4	753.23	85.59%	126.77	14.41%	331.14	16.60%	$37,054	1,032.74	57.97%
Clear Creek	019	4,019	9,412	$50,997	396.4	3,720.28	92.57%	298.72	7.43%	678.56	7.21%	$50,997	265.16	66.89%
Conejos	021	2,980	8,388	$24,744	1,290.8	2,885.77	96.84%	94.23	3.16%	228.66	2.73%	$24,744	548.64	42.50%
Costilla	023	1,503	3,548	$19,531	1,230.3	1,447.59	96.31%	55.41	3.69%	132.82	3.74%	$19,531	342.24	27.82%
Crowley	025	1,358	7,189	$26,803	800.2	1,084.61	79.87%	273.39	20.13%	959.66	13.35%	$26,803	746.25	93.26%
Custer	027	1,480	4,100	$34,731	739.9	822.39	55.57%	657.61	44.43%	1,566.63	38.21%	$34,731	600.76	81.19%
Delta	029	11,058	30,959	$32,785	1,148.6	10,735.53	97.08%	322.47	2.92%	766.60	2.48%	$32,785	406.65	35.40%
Denver	031	239,235	596,582	$39,500	154.9	239,145.00	99.96%	90.00	0.04%	152.00	0.03%	$39,500	27.99	18.07%
Dolores	033	785	1,937	$32,196	1,068.1	591.58	75.36%	193.42	24.64%	446.18	23.03%	$32,196	985.18	92.24%
Douglas	035	60,924	275,121	$82,929	842.8	60,133.50	98.70%	790.50	1.30%	2,114.66	0.77%	$82,929	323.04	38.33%
Eagle	037	15,148	52,532	$62,682	1,691.7	14,066.30	92.86%	1,081.70	7.14%	2,717.21	5.17%	$62,682	1,490.99	88.14%
Elbert	039	6,770	23,092	$62,480	1,851.0	5,353.76	79.08%	1,416.24	20.92%	4,135.72	17.91%	$62,480	1,280.42	69.17%
El Paso	041	192,409	587,590	$46,844	2,129.6	190,653.37	99.09%	1,755.63	0.91%	5,157.28	0.88%	$46,844	968.31	45.47%
Fremont	043	15,232	48,005	$34,150	1,533.9	13,375.48	87.81%	1,856.52	12.19%	9,012.85	18.77%	$34,150	1,349.86	88.00%
Garfield	045	16,229	55,063	$47,016	2,955.9	14,810.52	91.26%	1,418.48	8.74%	4,015.79	7.29%	$47,016	2,624.40	88.79%
Gilpin	047	2,043	5,137	$51,942	150.3	1,908.63	93.42%	134.37	6.58%	296.43	5.77%	$51,942	46.70	31.07%
Grand	049	5,075	14,383	$47,759	1,870.7	4,087.26	80.54%	987.74	19.46%	2,533.31	17.61%	$47,759	1,759.78	94.07%
Gunnison	051	5,649	15,048	$36,916	3,259.9	4,580.45	81.08%	1,068.55	18.92%	2,684.53	17.84%	$36,916	3,144.62	96.46%
Hinsdale	053	359	870	$37,279	1,123.1	258.19	71.92%	100.81	28.08%	236.31	27.16%	$37,279	1,095.23	97.52%
Huerfano	055	3,082	7,958	$25,775	1,593.3	2,336.57	75.81%	745.43	24.19%	2,490.22	31.29%	$25,775	1,474.11	92.52%
Jackson	057	661	1,476	$31,821	1,620.0	468.12	70.82%	192.88	29.18%	515.35	34.92%	$31,821	1,528.45	94.35%
Jefferson	059	206,067	538,323	$57,339	774.1	205,145.19	99.55%	921.81	0.45%	2,408.24	0.45%	$57,339	241.31	31.16%
Kiowa	061	665	1,469	$30,494	1,785.8	562.51	84.59%	102.49	15.41%	248.85	16.94%	$30,494	1,074.13	60.15%
Kit Carson	063	2,990	8,144	$33,152	2,161.6	2,819.47	94.30%	170.53	5.70%	471.15	5.79%	$33,152	651.99	30.16%
Lake	065	2,977	8,190	$37,691	383.9	2,400.84	80.65%	576.16	19.35%	1,638.63	20.01%	$37,691	368.99	96.12%
La Plata	067	17,342	49,758	$40,159	1,700.0	15,715.91	90.62%	1,626.09	9.38%	4,076.42	8.19%	$40,159	1,144.71	67.34%
Larimer	069	97,164	288,244	$48,655	2,634.0	95,176.81	97.95%	1,987.19	2.05%	4,830.83	1.68%	$48,655	1,900.06	72.14%
Las Animas	071	6,173	16,568	$28,273	4,775.5	4,831.76	78.27%	1,341.24	21.73%	3,341.93	20.17%	$28,273	4,149.53	86.89%
Lincoln	073	2,058	5,722	$31,914	2,586.6	1,595.96	77.55%	462.04	22.45%	1,716.34	30.00%	$31,914	1,664.36	64.35%
Logan	075	7,551	21,879	$32,724	1,844.9	7,402.58	98.03%	148.42	1.97%	376.03	1.72%	$32,724	184.41	10.00%
Mesa	077	45,823	140,416	$35,864	3,341.1	43,951.33	95.92%	1,871.67	4.08%	5,112.69	3.64%	$35,864	2,893.64	86.61%
Mineral	079	377	993	$34,844	877.8	236.12	62.63%	140.88	37.37%	318.05	32.03%	$34,844	832.22	94.81%
Moffat	081	4,983	13,928	$41,528	4,750.9	4,209.80	84.48%	773.20	15.52%	2,091.08	15.01%	$41,528	4,573.05	96.26%
Montezuma	083	9,201	25,561	$32,083	2,039.9	7,949.51	86.40%	1,251.49	13.60%	3,572.15	13.98%	$32,083	1,597.99	78.34%
Montrose	085	13,043	40,263	$35,234	2,242.5	11,850.04	90.85%	1,192.96	9.15%	2,860.56	7.10%	$35,234	1,583.96	70.63%
Morgan	087	9,539	28,573	$34,568	1,293.7	9,456.58	99.14%	82.42	0.86%	244.46	0.86%	$34,568	146.36	11.31%
Otero	089	7,920	19,129	$29,738	1,269.8	7,141.10	90.17%	778.90	9.83%	2,057.33	10.76%	$29,738	1,126.13	88.69%
Ouray	091	1,576	4,510	$42,019	542.3	1,501.17	95.25%	74.83	4.75%	182.22	4.04%	$42,019	247.51	45.64%
Park	093	5,894	17,005	$51,899	2,211.0	4,683.59	79.46%	1,210.41	20.54%	2,708.20	15.93%	$51,899	1,349.89	61.05%
Phillips	095	1,781	4,601	$32,177	687.8	1,738.48	97.61%	42.52	2.39%	113.62	2.47%	$32,177	53.50	7.78%
Pitkin	097	6,807	16,607	$59,375	973.2	5,949.01	87.40%	857.99	12.60%	1,961.91	11.81%	$59,375	840.72	86.39%
Prowers	099	5,307	13,407	$29,935	1,644.3	5,263.57	99.18%	43.43	0.82%	111.78	0.83%	$29,935	222.47	13.53%
Pueblo	101	54,579	155,723	$32,775	2,397.7	53,602.00	98.21%	977.00	1.79%	2,473.43	1.59%	$32,775	1,479.42	61.70%
Rio Blanco	103	2,306	6,434	$37,711	3,222.7	1,832.73	79.48%	473.27	20.52%	1,211.37	18.83%	$37,711	3,164.89	98.21%
Rio Grande	105	4,701	12,594	$31,836	913.4	4,325.85	92.02%	375.15	7.98%	922.20	7.32%	$31,836	505.58	55.35%
Routt	107	7,953	23,060	$53,612	2,368.1	6,734.63	84.68%	1,218.37	15.32%	3,031.12	13.14%	$53,612	1,778.29	75.09%
Saguache	109	2,300	6,921	$25,495	3,170.2	1,692.69	73.60%	607.31	26.40%	1,468.36	21.22%	$25,495	2,915.61	91.97%
San Juan	111	269	571	$30,764	388.3	206.46	76.75%	62.54	23.25%	123.06	21.55%	$30,764	387.55	99.81%
San Miguel	113	3,015	7,684	$48,514	1,288.5	2,259.66	74.95%	755.34	25.05%	1,660.75	21.61%	$48,514	1,219.96	94.68%
Sedgwick	115	1,165	2,509	$28,278	549.5	1,051.46	90.25%	113.54	9.75%	254.89	10.16%	$28,278	311.84	56.75%
Summit	117	9,120	28,611	$56,587	619.2	8,585.64	94.14%	534.36	5.86%	1,281.96	4.48%	$56,587	480.72	77.64%
Teller	119	7,993	22,883	$50,165	559.0	6,402.94	80.11%	1,590.06	19.89%	3,977.02	17.38%	$50,165	387.69	69.35%
Washington	121	1,989	4,833	$32,431	2,524.1	1,671.58	84.04%	317.42	15.96%	814.70	16.86%	$32,431	1,177.03	46.63%
Weld	123	63,247	244,515	$42,321	4,017.2	62,513.11	98.84%	733.89	1.16%	2,101.02	0.86%	$42,321	1,357.58	33.79%
Yuma	125	3,800	9,973	$33,169	2,369.0	3,601.48	94.78%	198.52	5.22%	560.51	5.62%	$33,169	596.09	25.16%
		1,658,238	4,919,884	$39,428	104,094									
STATE						1,617,322.47	97.53%	40,915.53	2.47%	110,467.26	2.25%	$39,428	69,477.4	66.74%

County	FIPS	Total HH 2000 Census	2007 Population Estimate	Median Income 2000 Census	Area in Square Miles	Broadband Covered HH (2000 Census)	County HH Availability	Unserved Households (2000 Census)	County HH Unavailability	Unserved Population (2007 Estimates)	County Population Unavailability	Median Income of Unserved (2000 Census)	Unserved Area in Square Miles	Percent of Total Area Unserved
Adams	001	128,156	424,379	$47,323	1,183.5	128,149.78	100.00%	6.22	0.00%	6.22	0.00%	$47,323	27.52	2.32%
Alamosa	003	5,467	15,760	$29,447	723.4	5,466.00	99.98%	1.00	0.02%	0.00	0.00%	$29,447	0.33	0.05%
Arapahoe	005	190,909	551,733	$53,570	805.6	190,900.24	100.00%	8.76	0.00%	7.76	0.00%	$53,570	59.58	7.40%
Archuleta	007	3,980	12,625	$37,901	1,354.6	3,751.14	94.25%	228.86	5.75%	228.86	1.81%	$37,901	471.10	34.78%
Baca	009	1,905	4,188	$28,099	2,557.1	1,795.77	94.27%	109.23	5.73%	109.23	2.61%	$28,099	769.63	30.10%
Bent	011	2,003	5,926	$28,125	1,541.2	1,986.03	99.15%	16.97	0.85%	16.97	0.29%	$28,125	184.45	11.97%
Boulder	013	114,680	294,654	$55,861	740.5	113,926.41	99.34%	753.59	0.66%	749.59	0.25%	$55,861	164.42	22.20%
Broomfield	014	*	53,691	*	33.4	*	*	*	*	*	*	*	*	*
Chaffee	015	6,584	16,942	$34,368	1,014.7	6,454.33	98.03%	129.67	1.97%	129.67	0.77%	$34,368	348.65	34.36%
Cheyenne	017	880	1,995	$37,054	1,781.4	875.80	99.52%	4.20	0.48%	4.20	0.21%	$37,054	64.44	3.62%
Clear Creek	019	4,019	9,412	$50,997	396.4	3,973.73	98.87%	45.27	1.13%	45.27	0.48%	$50,997	70.83	17.87%
Conejos	021	2,980	8,388	$24,744	1,290.8	2,885.77	96.84%	94.23	3.16%	94.23	1.12%	$24,744	548.47	42.49%
Costilla	023	1,503	3,548	$19,531	1,230.3	1,447.59	96.31%	55.41	3.69%	55.41	1.56%	$19,531	341.89	27.79%
Crowley	025	1,358	7,189	$26,803	800.2	1,332.71	98.14%	25.29	1.86%	25.29	0.35%	$26,803	184.22	23.02%
Custer	027	1,480	4,100	$34,731	739.9	1,237.54	83.62%	242.46	16.38%	242.46	5.91%	$34,731	158.07	21.36%
Delta	029	11,058	30,959	$32,785	1,148.6	10,907.21	98.64%	150.79	1.36%	142.79	0.46%	$32,785	221.99	19.33%
Denver	031	239,235	596,582	$39,500	154.9	239,146.00	99.96%	89.00	0.04%	0.00	0.00%	$39,500	0.00	0.00%
Dolores	033	785	1,937	$32,196	1,068.1	684.17	87.16%	100.83	12.84%	100.83	5.21%	$32,196	784.27	73.43%
Douglas	035	60,924	275,121	$82,929	842.8	60,758.87	99.73%	165.13	0.27%	165.13	0.06%	$82,929	119.33	14.16%
Eagle	037	15,148	52,532	$62,682	1,691.7	14,828.79	97.89%	319.21	2.11%	319.21	0.61%	$62,682	648.00	38.30%
Elbert	039	6,770	23,092	$62,480	1,851.0	6,566.61	97.00%	203.39	3.00%	203.39	0.88%	$62,480	112.48	6.08%
El Paso	041	192,409	587,590	$46,844	2,129.6	192,153.83	99.87%	255.17	0.13%	240.17	0.04%	$46,844	183.30	8.61%
Fremont	043	15,232	48,005	$34,150	1,533.9	14,601.27	95.86%	630.73	4.14%	630.73	1.31%	$34,150	484.51	31.59%
Garfield	045	16,229	55,063	$47,016	2,955.9	16,072.32	99.03%	156.68	0.97%	137.68	0.25%	$47,016	1,483.78	50.20%
Gilpin	047	2,043	5,137	$51,942	150.3	1,965.06	96.19%	77.94	3.81%	77.94	1.52%	$51,942	23.35	15.54%
Grand	049	5,075	14,383	$47,759	1,870.2	5,047.95	99.47%	27.05	0.53%	27.05	0.19%	$47,759	392.16	20.96%
Gunnison	051	5,649	15,048	$36,916	3,259.9	5,225.91	92.51%	423.09	7.49%	423.09	2.81%	$36,916	2,003.16	61.45%
Hinsdale	053	359	870	$37,279	1,123.1	259.25	72.21%	99.75	27.79%	99.75	11.47%	$37,279	994.17	88.52%
Huerfano	055	3,082	7,958	$25,775	1,593.3	3,023.62	98.11%	58.38	1.89%	58.38	0.73%	$25,775	140.51	8.82%
Jackson	057	661	1,476	$31,821	1,620.0	609.24	92.17%	51.76	7.83%	51.76	3.51%	$31,821	476.53	29.42%
Jefferson	059	206,067	538,323	$57,339	774.1	205,835.93	99.89%	231.07	0.11%	231.07	0.04%	$57,339	115.35	14.90%
Kiowa	061	665	1,469	$30,494	1,785.8	635.14	95.51%	29.86	4.49%	29.86	2.03%	$30,494	374.16	20.95%
Kit Carson	063	2,990	8,144	$33,152	2,161.6	2,975.99	99.53%	14.01	0.47%	14.01	0.17%	$33,152	52.98	2.45%
Lake	065	2,977	8,190	$37,691	383.9	2,911.52	97.80%	65.48	2.20%	65.48	0.80%	$37,691	140.40	36.57%
La Plata	067	17,342	49,758	$40,159	1,700.0	17,247.21	99.45%	94.79	0.55%	90.79	0.18%	$40,159	166.59	9.80%
Larimer	069	97,164	288,244	$48,655	2,634.0	95,980.45	98.78%	1,183.55	1.22%	1,183.55	0.41%	$48,655	1,132.07	42.98%
Las Animas	071	6,173	16,568	$28,273	4,775.5	5,628.55	91.18%	544.45	8.82%	544.45	3.29%	$28,273	1,965.31	41.15%
Lincoln	073	2,058	5,722	$31,914	2,586.6	1,933.78	93.96%	124.22	6.04%	124.22	2.17%	$31,914	679.95	26.29%
Logan	075	7,551	21,879	$32,724	1,844.9	7,540.89	99.87%	10.11	0.13%	10.11	0.05%	$32,724	54.77	2.97%
Mesa	077	45,823	140,416	$35,864	3,341.1	45,543.33	99.39%	279.67	0.61%	279.67	0.20%	$35,864	1,201.63	35.97%
Mineral	079	377	993	$34,844	877.8	261.18	69.28%	115.82	30.72%	115.82	11.66%	$34,844	580.15	66.09%
Moffat	081	4,983	13,928	$41,528	4,750.9	4,835.10	97.03%	147.90	2.97%	147.90	1.06%	$41,528	2,098.79	44.18%
Montezuma	083	9,201	25,561	$32,083	2,039.2	9,060.76	98.48%	140.24	1.52%	140.24	0.55%	$32,083	557.17	27.31%
Montrose	085	13,043	40,263	$35,234	2,242.5	12,365.61	94.81%	677.39	5.19%	677.39	1.68%	$35,234	947.70	42.26%
Morgan	087	9,539	28,573	$34,568	1,293.7	9,537.74	99.99%	1.26	0.01%	1.26	0.00%	$34,568	6.67	0.52%
Otero	089	7,920	19,129	$29,738	1,269.8	7,890.54	99.63%	29.46	0.37%	29.46	0.15%	$29,738	305.65	24.07%
Ouray	091	1,576	4,510	$42,019	542.3	1,535.41	97.42%	40.59	2.58%	40.59	0.90%	$42,019	150.87	27.82%
Park	093	5,894	17,005	$51,899	2,211.0	5,418.81	91.94%	475.19	8.06%	472.19	2.78%	$51,899	596.90	27.00%
Phillips	095	1,781	4,601	$32,177	687.8	1,781.00	100.00%	0.00	0.00%	0.00	0.00%	$32,177	0.26	0.04%
Pitkin	097	6,807	16,607	$59,375	973.2	6,532.74	95.97%	274.26	4.03%	274.26	1.65%	$59,375	532.57	54.72%
Prowers	099	5,307	13,407	$29,935	1,644.3	5,281.20	99.51%	25.80	0.49%	25.80	0.19%	$29,935	147.94	9.00%
Pueblo	101	54,579	155,723	$32,775	2,397.7	54,332.74	99.55%	246.26	0.45%	246.26	0.16%	$32,775	177.04	7.38%
Rio Blanco	103	2,306	6,434	$37,711	3,222.7	1,995.96	86.56%	310.04	13.44%	310.04	4.82%	$37,711	1,638.39	50.84%
Rio Grande	105	4,701	12,594	$31,836	913.4	4,663.57	99.20%	37.43	0.80%	37.43	0.30%	$31,836	166.29	18.21%
Routt	107	7,953	23,060	$53,612	2,368.1	7,810.80	98.21%	142.20	1.79%	142.20	0.62%	$53,612	751.48	31.73%
Saguache	109	2,300	6,921	$25,495	3,170.2	2,204.77	95.86%	95.23	4.14%	95.23	1.38%	$25,495	1,389.67	43.84%
San Juan	111	269	571	$30,764	388.3	263.87	98.09%	5.13	1.91%	5.13	0.90%	$30,764	237.67	61.21%
San Miguel	113	3,015	7,684	$48,514	1,288.5	2,924.27	96.99%	90.73	3.01%	89.73	1.17%	$48,514	646.89	50.20%
Sedgwick	115	1,165	2,509	$28,278	549.5	1,165.00	100.00%	0.00	0.00%	0.00	0.00%	$28,278	0.15	0.03%
Summit	117	9,120	28,611	$56,587	619.2	9,012.76	98.82%	107.24	1.18%	103.24	0.36%	$56,587	122.81	19.83%
Teller	119	7,993	22,883	$50,165	559.0	7,265.96	90.90%	727.04	9.10%	727.04	3.18%	$50,165	137.30	24.56%
Washington	121	1,989	4,833	$32,431	2,524.1	1,924.03	96.73%	64.97	3.27%	64.97	1.34%	$32,431	212.98	8.44%
Weld	123	63,247	244,515	$42,321	4,017.2	63,192.41	99.91%	54.59	0.09%	52.59	0.02%	$42,321	150.51	3.75%
Yuma	125	3,800	9,973	$33,169	2,369.0	3,772.59	99.28%	27.41	0.72%	27.41	0.27%	$33,169	78.84	3.33%
		1,658,238	4,919,884	$39,428	104,094									
STATE						1,647,294.55	99.34%	10,943.45	0.66%	10,792.45	0.22%	$39,428	28,979.1	27.84%

APPENDIX B

DATABASE STRUCTURE OF VECTOR GEOGRAPHIC DATASET

Connected Nation Proposed Broadband Inventory Database Structure

Connected Nation proposes to develop the following Database Structure for the Broadband Inventory that Connect Colorado will be developing for the State of Colorado's Governor's Office for Information Technology. This Database Structure is considering the requirements set forth by OIT and the data that will be collected by Connect Colorado from providers, as well as additional data required by the State.

Necessary Data Sources:
- U.S. Census Bureau Census block boundaries, based on the most recent TIGER file release.
- Broadband Availability data collected from the Broadband Service Providers of Colorado.

The database structure would consist of the following Attributes:

BLOCKIDFP00:	Census Block Code
TRACT00:	Census Tract Code
COUNTYFP00:	County Federal Information Processing Standard Code
STATEFP00:	State Federal Information Processing Standards Code
UR00:	Census Urban/Rural Indicator
HHBBAVAIL:	Estimated Household availability for the given Census Block
NOBBHH:	Estimated Households without any Availability of Broadband
POP2000	Population from 2000 census
POP2008	Estimated Current Population
AREA_SQMI	Area in Square Miles
POP_DENS	Population Density
FCCTIER:	Highest Available FCC Speed Tier
PTYPCABLE:	Presence of Cable Broadband (Yes/No)
PTYPDSL:	Presence of DSL Broadband (Yes/No)
PTYPFWIRE:	Presence of Fixed Wireless Broadband (Yes/No)
PTYPMOBILE:	Presence of Mobile Wireless Broadband (Yes/No)
PTYPOTHER:	Presence of Other Broadband Platform (Yes/No)

For the attributes HHBBAVAIL and NOBBHH Connect Colorado will determine these by distributing the Number of Households in each Census Block to the road line network and will base the attribute values from the number of these households that are determined to have broadband available based on the broadband footprint.

APPENDIX C

PUBLIC MEETINGS AND PRESENTATIONS

Connect Colorado conducted no less than 40 public meetings or presentations on behalf of the program.

06/23/2009	Connect Colorado conducted Program Kick-off Conference Call.
07/01/2009	Connect Colorado personnel testified before the Colorado Governor's Innovation Council
09/28/2009	Connect Colorado met with the Glenwood Springs Chamber of Commerce.
09/28/2009	Connect Colorado met with City of Glenwood Springs (J. Hecksel, City Mgr)
09/30/2009	Connect Colorado met with Carbondale Chamber of Commerce (A. Stewart, Marketing & Tourism)
09/30/2009	Connect Colorado met with Rifle Economic Development Corp. (K. Daler, President)
09/30/2009	Connect Colorado met with Rifle Chamber of Commerce (A. Pruett, President)
09/30/2009	Connect Colorado met with Robert Knight - Town Manager - Parachute.
09/30/2009	Connect Colorado met with Town of Carbondale - Doug Dotson, Community Development Director.
10/01/2009	Connect Colorado met with Garfield County - Dale Hancock, Director of Operations and Charles Zelenka, Director of IT.
10/01/2009	Connect Colorado met with Town of New Castle - Andy Barton, City Administrator and Gary Atkinson, IT Manager.

10/05/2009	Connect Colorado met with Weld County (S. Moreno, Clerk &Recorder, R. Cox, Information Systems)
10/05/2009	Connect Colorado met with Greeley Tribune (Weld County's largest daily newspaper)
10/05/2009	Connect Colorado met with City of Greeley (P. Stokes, Dir of IT)
10/05/2009	Connect Colorado met with Greeley Chamber of Commerce (K. Barbour, Comm. Dir.)
10/05/2009	Connect Colorado met with Town of Eaton (G. Carsten Town Mgr)
10/05/2009	Connect Colorado met with The North Weld Herald (Eaton newspaper, B. Bormann, Publisher)
10/05/2009	Connect Colorado met with Evans Area Chamber of Commerce (M. Jones, Dir.)
10/05/2009	Connect Colorado met with Upstate Colorado – Weld County Economic Dev. (T. Hammerschmidt, Off. Mgr)
10/05/2009	Connect Colorado met with High Plains Library Dist. (G. Anderson, Services Supr.)
10/05/2009	Connect Colorado met with KFKA, 1310 AM (J. Sasso, GM)
10/05/2009	Connect Colorado met with KUNC, 91.5 FM (NPR), (R. Thompson)
10/05/2009	Connect Colorado met with KGRE, 1450 AM (Spanish radio), (Y. Rodriguez)
10/05/2009	Connect Colorado met with Town of Eaton (G. Carsten, Administrator)
10/06/2009	Connect Colorado met with Prairie School District RE-11J (J. Kimmel, Supt)
10/06/2009	Connect Colorado met with Town of Kersey (T. McCoy, Town Administrator)
10/06/2009	Connect Colorado met with Progressive 15 (C. Schull, CEO)
10/12/2009	Connect Colorado met with Las Animas County (W. Cordova, County Administrator)

10/13/2009	Connect Colorado met with Las Animas County Economic Development (M. Aragon, Facilitator)
10/13/2009	Connect Colorado met with Carnegie Library District (J. Besset, Dir.).
10/13/2009	Connect Colorado met with Trinidad Community Center
10/14/2009	Connect Colorado met with Trinidad State Jr. College.
10/14/2009	Connect Colorado met with City of Aguilar, CO (T. Avila, Treasurer/Clerk)
10/14/2009	Connect Colorado met with Weston School District
10/14/2009	Connect Colorado met with Aguilar School District
10/14/2009	Connect Colorado met with Aguilar Community Center
10/15/2009	Connect Colorado met with Kim School District.
10/15/2009	Connect Colorado met with Hoehne School District
10/15/2009	Connect Colorado met with Branson School Online (R. Kuhns, Dir.)
10/29/2009	Connect Colorado presented before the Colorado state Innovation Council.

APPENDIX D

CONNECT COLORADO WEB STATISTICS

Connect Colorado launched the program's website (www.connectcolorado.org) on July 14, 2009. This program and mapping website for Colorado was equipped with an upstream/downstream speed test tool that will be used along with SpeedTest.net data to measure broadband upload and download speeds at the county level of detail.

	Total # of Visits	From Direct Hits	From Search Engine	From Referring Site	From Other	# of Unique Visits	Avg. Time on Site	Day w/the Most Visits	# of Visits
July	239	196	24	19	0	165	3:03	16th	38
Aug	174	120	32	22	0	140	1:30	6th	13
Sept	702	415	72	215	0	522	2:31	11th	111
Oct	1008	351	107	550	0	872	2:32	7th	107

RESULTS FROM JULY 14TH THROUGH NOVEMBER 1ST
WWW.CONNECTCOLORADO.ORG